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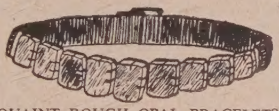

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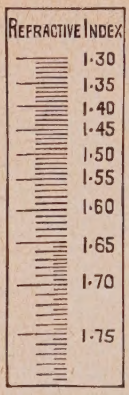

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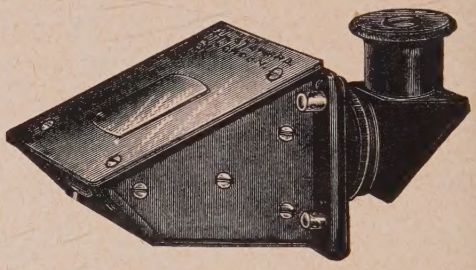

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The paragenesis of cookeite and hydromuscovite associated with gold at Ogofau, Carmarthenshire.

(With Plate XIX.)

By A. Brammall, D.Sc., Ph.D., Assoc. Inst. M.M.
J. G. C. Leech, A.R.S.M., Assoc. Inst. M.M.
Geological Department, Imperial College of Science and Technology, London,
and F. A. Bannister, M.A.
Assistant-Keeper in the Mineral Department of the British Museum of Natural History.

[Read January 28, 1937.]

THIS paper describes occurrences of cookeite (not previously recorded as a British species) and hydromuscovite associated with auriferous pyrite and arsenopyrite, blende, galena, carbonates, and free gold at Ogofau, on the left bank of the river Cothi, half a mile SSE. of Pumpsaint, Carmarthenshire.

The hillside around Ogofau is scarred with opencast workings and trenches reputed to be an 'ancient gold mine' dating back to Roman times. Though the mine is described as 'disused' on the Ordnance Survey map (six-inches/mile, Sheet XVII, NW.), these surface workings have been exploited for free gold intermittently within the last fifty years, and recent development work (by the Roman Deep Holdings, Ltd.) from a shaft sunk in 1910 is approaching the producing stage.

The old workings are scattered over a belt which coincides wit a mineralized thrust-zone transgressing the boundary between Valen tian (Lower Birkhill) beds and the underlying Ordovician (Bala) bed exposed by a minor up-fold on the west flank of the main Tow anticline. In both these horizons the normal facies comprise cleaved blue-black shales and mudstones with occasional thin band of grit.

The surface workings expose ochreous shales impregnated wit pyrite and arsenopyrite, and banded with narrow gossanous zone quartz veins, and numerous veinlets of white hydromica in intimat association with quartz, auriferous sulphides, and occasionally fre gold. The last is frequently obtainable by panning crushed sample taken from quartzose shatter-belts in the gossanous ground. Th opencast work appears to have prospected numerous hydrotherm 'blow-zones' and minor arteries of mineralization structurally relate to ore-bodies disclosed by recent underground development work.

These ore-bodies are mainly sheet- and saddle-like masses pyritic quartz intercalated along bedding planes in small drag-fol on the flank of the anticlinal. Typically, an ore-body is traceab from a feather-edge sheet low down on the flanks of a minor up-fol into a substantial quartz-body attaining its maximum thickne towards the crest of the fold, where it is usually involved in a steep inclined shear-zone.

Shales marginal to these ore-bodies are usually impregnated wit sulphides over varying thicknesses above and below the contact, ar particular bands in the shale are selectively metasomatized to compact stony aggregate of auriferous sulphides and quartz. Ban of similar 'stone pyrite' occur also in shale-ground remote from ar known, or suspected, body of pyritic quartz, and such shales common contain conspicuous dice-like crystals of arsenopyrite and pyrite.

Hydromuscovite is habitually associated with sulphides in bo shale-ground and ore-bodies. It is specially abundant in veinle which also carry coarsely crystalline auriferous sulphides, quart and usually a little free gold. These micaceous veinlets are of su frequent occurrence in the lower levels of the mine that water drain from a working face is turbid with finely divided white mica.

Cookeite, on the other hand, is more restricted in its distributio It has not yet been observed in the surface workings and is ve rare in the upper levels of the mine. It was first noticed on t third (420-foot) level as a mica-like deposit in small cavities a

ong shear- and fracture-planes traversing ore-body and shale-ground like. It was next observed as the material grouting localized asses of shale-breccia. Unlike the hydromuscovite, the cookeite rarely in intimate admixture with sulphides: its deposition curred after the emplacement of the sulphide-quartz-hydromica re-bodies.

The following table gives an approximate assessment of lode-ntent based on a considerable tonnage of high-grade pyritic ore ken from a stope on the third (420-foot) level:

Quartz	53·0%
Hydromuscovite	6·0
Cookeite	0·1
Carbonates	0·2
Graphite	trace
Blende and galena	2·0
Auriferous pyrite and arsenopyrite ...	38·7
	100·0

Elements supplementary to those accounted for by the lode-inerals listed above have been determined spectroscopically by r. V. L. Aspland, A.R.S.M., whose findings are summarized below:

Traces	B,Sn,Sb,Bi.
Minute traces	Ba,Cd,In,Ga,Ge,Cr,V,Ni,Co.

Quartz is mainly the 'milky' variety, and shows marked tribo-minescence. It is characterized by abundant minute cavities con-ining fluid, with mobile bubbles. Water-clear crystals are confined vughs.

Hydromuscovite is mainly a lustrous silver-white to cream-coloured riety, grading into a pale, prase-green, wax-like, massive variety neering planes of compression and shear. Both varieties are very ft, easily deformed, and talc-like to the touch. An aggregate of ely divided mica takes on the consistency of clay when wetted.

Cookeite occurs mainly as a patchy film or incrustation on other de-minerals. Its rarity in the higher levels of the mine, and the quency of its occurrence in drill-cores drawn from below the esent bottom (420-foot) level, suggest that it is both more wide-read and more abundant at depths below this level.

Carbonate is mainly calcite, with ferruginous dolomite as an casional associate. Chalybite and ankerite are known to occur in e matrix of the mineralized mica-rich shales.

Graphite is probably derived from cleaved black-shales, some of ich are known to contain finely divided graphite.

Blende and *galena* together are subordinate to the other sulphide but they are the main constituents of a vertical cross-course traceal from surface to depth.

Gold is intimately associated with the pyrite and arsenopyri Concentrates of these two sulphides yield gold in quantities varyi from pennyweights to 3 ounces or more per ton. The Au : Ag ratio run-of-mine ore is approximately 1 : 8. Coarse and fine granu gold is occasionally found in lode-quartz. Gold residual after s phides is represented by granular, arborescent, and 'wire' g occurring in small ferruginous pockets in lode-quartz and elsewher

Cookeite.

The mineral ultimately identified (by F. A. B.) as cookeite w first observed by the senior author[1] as an incrustation on lo minerals in an ore-body on the third (420-foot) level of the mi Preliminary X-ray powder photographs on carefully selected mater were taken by Dr. G. Nagelschmidt, who obtained a pattern clos resembling those of dickite and clinochlore. The mineral analy was fractionated from material grouting disturbed ground on t third level. The raw sample was a creamy-white, compact l friable mass, with a silky sheen on hackly fracture surfaces an mica-like lustre when dispersed in water. The analysis no. 1, tabl was done on material carefully freed from quartz, and a port of the sample analysed was subjected to optical and further X-r investigations. The mineral consists of pale-cream, transpar plates of irregular outline not exceeding $\frac{1}{2}$ mm. across, and rar more than 1/10 mm. in thickness. A few plates are semicircular outline and are probably detached from hemispherical aggregat The specific gravity determined in mixtures of bromoform a benzene is $2{\cdot}69 \pm 0{\cdot}01$. Most of the plates give a sharp biax positive interference-figure (optic axial plane parallel to the a [100]), 2E 80°; and the refractive indices determined by the Be method are α 1·575, β 1·580, γ 1·595 for sodium-light. Both optical properties and chemical analysis suggest the identity of mineral with cookeite from Maine, U.S.A.

Cookeite, discovered in 1862 or 1863 on specimens of lepidol from Hebron, Maine, by J. P. Cooke, was described as a white

[1] Several specimens, including a portion of the material used for chem analysis, have been presented to the Trustees of the British Museum.

yellowish-green, pearly, micaceous mineral resembling nacrite which, when heated before the blowpipe, exfoliated like vermiculite, at the same time colouring the flame a vivid lithium red. G J. Brush collected sufficient of this mineral for chemical analysis (no. 2, table I),

TABLE I. Chemical analyses of cookeite.

	1.	1*a*.	2.	3.	4.	5.	6.
SiO_2 ...	32·46	34·68	35·20	34·00	34·81	32·00	34·52
TiO_2 ...	0·03	0·03	—	—	—	—	—
Al_2O_3 ...	45·08	48·17	44·91	45·06	45·90	45·87	48·82
Fe_2O_3 ...	0·27	0·29	—	0·45	0·72	—	—
FeO ...	0·99	0·90	—	—	—	—	—
MnO ...	—	—	—	—	trace	—	—
MgO ...	0·35	—	—	—	—	0·78	—
CaO ...	2·73	—	—	0·04	trace	1·63	—
Na_2O ...	0·04	0·04	—	0·19	0·52	0·65	—
K_2O ...	—	—	2·57	0·14		0·06	—
Li_2O ...	2·29	2·45	2·82	4·02	3·59	2·10	2·86
H_2O+ ...	12·58	13·44	13·41	14·96	14·87	17·29	13·80
H_2O- ...	0·35	—	0·38				—
CO_2 ...	2·74	—	—	—	—	—	—
...	—	—	0·34	0·46	0·13	0·02	—
	99·91	100·00	99·63	99·32	100·54	100·40	100·00
less O = F ...	—	—	0·14	0·19	0·05	0·01	—
			99·49	99·13	100·49	100·39	—
Sp. gr. ...	2·69	—	2·70	2·675	2·67	—	—

1 1. Roman Deep mine, Ogofau, Pumpsaint, Carmarthenshire. Minute, pale-cream curved plates from cavities in quartz. Refractive indices α 1·575, β 1·580, 1·595 (sodium-light), positive, 2E 80°. Analyst, Miss Hilda Bennett, M.A., B.Sc.

1 1*a*. Analysis no. 1 recalculated to 100·00 after subtracting lime, magnesia, 1·15 % ferrous oxide, and carbon dioxide, which are present as dolomite.

2 2. Hebron and Paris, Maine. Extremely minute scales and hemispherical aggregates associated with lepidolite and rubellite. G. J. Brush, Amer. Journ. Sci., 1866, ser. 2, vol. 41, p. 246. Brush recorded SiO_2 34·93 and SiF_4 0·47 %; the latter is equivalent to SiO_2 0·27 and F 0·34 %.

3 3. Paris, Maine. The material chosen for analysis was associated only with quartz and tourmaline, thus avoiding contamination with lepidolite. S. L. Penfield, Amer. Journ. Sci., 1893, ser. 3, vol. 45, p. 393.

4. Buckfield, Maine. Pale-yellow, pink, and cream cleavages. Refractive indices α 1·576, β 1·579, γ 1·597, positive, 2V maximum 80°. Analyst, Miss Helen E. Vassar in K. K. Landes, Amer. Min., 1925, vol. 10, p. 390. [Min. Abstr., 3–203.]

5. Wait-a-bit Creek, Columbia river, British Columbia. Thin, foliated, greyish to silvery-white and pale apple-green layers in sericite-schist, and in the small cavities of quartz traversing the schist. Analyst, R. A. A. Johnston in G. C. Hoffmann, Ann. Rep. Geol. Surv. Canada, 1895, vol. 6, p. 22.

6. Theoretical figures corresponding to $LiAl_4Si_3AlO_{10}(OH)_8$.

and concluded it to be a new species intermediate in compositi between euphyllite and margarite. He named the new miner cookeite in 1866 after its discoverer. Further specimens collect by Brush from Paris and Hebron nearly thirty years later yield abundant material for a re-examination undertaken by S. L. Penfie (anal. 3), who also noted its hexagonal habit and occurrence hemispherical or globular aggregates up to 3 mm. in diamet Penfield concluded that cookeite is closely related to the chlorit and micas. An analysis (no. 4) of cookeite from Buckfield, Mai was carried out by Miss Helen E. Vassar, and a more detailed optic study was made by K. K. Landes upon the same material and up cookeite from Greenwood, Maine. Cookeite from Columbia riv has also been analysed (no. 5); and the mineral is reported from t pegmatites of Haddam Neck, Connecticut,[1] and of the Karibib a Omaruru districts in South-West Africa.[2]

The identity of cookeite from Ogofau was confirmed by sing crystal X-ray photographs, typical material from Hebron, Paris, a Buckfield in Maine, being chosen from the British Museum collecti for comparison. Rotation photographs of cookeite from Ogofau a Maine are identical, whereas clinochlore, muscovite, dickite, nacri and lepidolite give patterns that are readily distinguished (pl. x figs. 1–9).

Laue photographs of cookeite from Ogofau are of two types: a sharp spot and streak pattern revealing hexagonal or pseu hexagonal symmetry (fig. 1); (2) superposed hexagonal spot patte spread over an angular range of about 10° (fig. 2). Neither type photograph is characteristic of a single crystal, and since the pla are curved it is impossible to be certain whether the centre of t hexagonal pattern is displaced from the normal to the cleavage fa That is, if the mineral is truly monoclinic, it is impossible to meas the value of β. A rotation photograph of a curved plate yielding Laue pattern of type 1 shows streaks corresponding to diffracti from (001) and spots from ($hk0$) (fig. 4), revealing that each curv plate is made up of a large number of small flakes with their a-a in parallel alinement, but with their c-axes inclined to each other small angles. A Laue photograph of type 1, of a flake aggreg

[1] H. L. Bowman, Min. Mag., 1902, vol. 13, p. 118.

[2] T. W. Gevers and H. F. Frommurze, Trans. Geol. Soc. South Africa, 19 vol. 32 (for 1929), p. 139. [M.A. 4–411.] W. P. de Kock, Trans. Geol. S South Africa, 1933, vol. 35 (for 1932), p. 97. [M.A. 5–421.]

a-axes parallel) consists of 'white' radiation streaks and a superposed monochromatic spot pattern (tungsten L radiation) due to flakes near the centre of the aggregate. Hence each curved plate behaves like a section of a spherulite, and shows a characteristic brush in parallel polarized light.[1] The Laue photograph of type 2 corresponds to a flake aggregate which has been deformed. The individual flakes no longer lie on a curved surface with their *a*-axes parallel, but are now spread fanwise; and the optic axial angle is lowered by amounts dependent on the angular spread resulting from the deformation. The measurement of the optic axial angle of platy aggregates is, of course, far more sensitive to lack of alinement parallel to the *a*-axis than to a small tilt of the individual flakes to the *c*-axis. Curved flake aggregates, with their *a*-axes strictly parallel, are characteristic not only of cookeite but also of chlorites, vermiculites, pyrophyllite, talc, and nacrite. Hendricks has also recorded the same type of flake aggregate for kaolinite. He found 'that the angle of deviation of individual fragments from the cleavage plane is approximately 12°–15°', and notes that in this particular type of crystalline aggregate 'it is interesting that the displacement of the individual fragments was unaccompanied by rotation about the normal to the cleavage surface'.[2] On the other hand, dickite, muscovite, and probably all unaltered micas yield true single-crystal X-ray photographs.

One of the plates yielding a good Laue pattern of type 1 was selected for rotation photographs and oriented to give the *a* and *b* spacings respectively. The *c* spacing was deduced from the basal cleavage 'streaks' on the equators of photographs about the *a* and *b* axes. The dimensions obtained are *a* 5·13, *b* 8·93, *c* 28·30 Å. If the mineral is truly monoclinic with $\beta \neq 90°$, then the value 28·30 Å. corresponds to the spacing $c \sin \beta$ of the (001) planes and not to the true unit-cell dimension *c*. We may, however, calculate the unit-cell volume $abc \sin \beta$, and, knowing also the specific gravity and percentage of oxygen, proceed in the usual way to calculate the number of oxygen atoms in the unit cell. This number is 72·37; assuming that the unit cell contains 72 oxygen atoms, the specific gravity is calculated to be 2·676, in close agreement with the observed value 2·69. All the available analyses of cookeite have been recalculated

[1] No flakes, however, were found with a uniaxial centre surrounded by a biaxial rim, similar to those recorded by Penfield and Landes from Maine.

[2] S. B. Hendricks, Zeits. Krist., 1929, vol. 71, p. 269. [M.A. 4–160.]

on the basis of 56 oxygen atoms per unit cell, excluding the wate content, to give the atomic contents (table II). There are tw quantities which remain appreciably constant, the number of silico atoms, approximately 12, and the total number of metal atom including silicon, approximately 36 per unit cell. The lithium cor tent varies, however, from 3·08 to 5·80, and it must be remembere

TABLE II. Analyses of cookeite recalculated to give the number of atoms per unit cell.

	1.*	2.	3.	4.	5.
Si	12·16	13·16	12·20	12·24	11·72
Al	19·90	17·78	19·04	19·04	19·80
Fe'''	0·08	—	0·08	0·20	—
Fe''	0·26	—	—	—	—
Mg	—	—	—	—	0·44
Ca	—	—	—	—	0·64
Na	0·03	--	0·12	0·28	0·48
K	—	1·13	0·08	—	0·04
Li	3·45	4·24	5·80	5·08	3·08
F	—	0·40	0·52	—	—
H_2O	15·71	16·61	17·88	17·44	21·12
ΣSi,Al,Li, &c. ...	35·88	36·31	37·32	36·84	36·20

* The chemical analysis of cookeite from Ogofau has been recalculated a basis of 72(O,OH) atoms per unit cell. Owing to the possible inaccuracy the water determinations, nos. 2 to 5 have been calculated on the basis of oxygen atoms per unit cell, neglecting the water content.

that the older methods of analysis were liable to give too high valu for lithia determinations. Thus we find that Miss Bennett's analys of cookeite from Ogofau contains a lower lithia figure than Brush's Penfield's, and also yields a figure nearer to 36 for the total Si + meta atoms per unit cell. Assuming that the crystal-structure of cookeit like all members of the mica, chlorite, and clay families, is base upon a hexagonal layer of composition $(Si,Al)_4O_{10}$, the unit-cell co tents of cookeite may be written from table II, $4(Li,Al)_5Si_3AlO_{10}(OH$ or approximating to $4LiAl_4Si_3AlO_{10}(OH)_8$. The three availab analyses of cookeite from Maine show that small quantities sodium, potassium, &c., should also be included with lithium. Th relationship of cookeite to similar minerals with layer-structures shown in the following table III. Deviations from the numbe given in the third column are well known, and a general theo explaining them will be offered at a future date. Pauling[1] a McMurchy[2] have shown that the structure of chlorite is built up

[1] L. Pauling, Proc. Nat. Acad. Sci. U.S.A., 1930, vol. 16, p. 578. [M.A. 4–46

[2] R. C. McMurchy, Zeits. Krist., 1934, vol. 88, p. 420. [M.A. 6–45.]

alternating layers of $[Mg_3Si_3AlO_{10}(OH)_2]^{-1}$ and $[Mg_2Al(OH)_6]^{+}$. The negatively charged layers are the same as those existing in magnesian micas, but instead of being linked by potassium ions they alternate with brucite-like layers in which one atom of magnesium is replaced

TABLE III. Atomic contents and unit-cell dimensions * of cookeite and related minerals.

	¼ unit-cell contents.	Total metal atoms per unit cell.	Cell dimensions: a.	b.	$c \sin\beta$.
Chlorite ...	$Mg_5AlSi_3AlO_{10}(OH)_8$	40	5·30	9·19	28·27 Å.
Cookeite ...	$LiAl_4Si_3AlO_{10}(OH)_8$	36	5·13	8·93	28·30
Dickite ...	$Al_4Si_4O_{10}(OH)_8$	32	5·15	8·95	28·68
Nacrite ...	$Al_4Si_4O_{10}(OH)_8$	32	5·15	8·95	28·70
Lepidolite ...	$K(Li,Al)_3(Si,Al)_4O_{10}(OH)_2$	32	5·18	9·02	19·97
Muscovite ...	$KAl_2Si_3AlO_{10}(OH)_2$	28	5·18	9·02	19·95
Talc ...	$Mg_3Si_4O_{10}(OH)_2$	28	5·26	9·14	18·52
Pyrophyllite ...	$Al_2Si_4O_{10}(OH)_2$	24	5·14	8·90	18·37

* Unit-cell dimensions of these minerals have been redetermined on specimens in the British Museum collections, with the exception of chlorite [1] and muscovite.[2]

TABLE IV. Sequence of atomic planes along a direction perpendicular to the c (001) plane for half the unit-cell height.

Phlogopite.	Chlorite.	Cookeite.	Muscovite.	Dickite.	Talc.
O_6	↑ O_6	↑ O_6	↑ O_6	↑ O_6	↑ O_6
Si_3Al	Si_3Al	Si_3Al	Si_3Al	Si_4	Si_4
$O_4(OH)_2$	$O_4(OH)_2$	$O_4(OH)_2$	$O_4(OH)_2$	$O_4(OH)_2$	$O_4(OH)_2$
Mg_6	Mg_6	Al_4	Al_4	Al_4	Mg_6
$O_4(OH)_2$	14·14 Å. $O_4(OH)_2$	14·15 Å. $O_4(OH)_2$	9·97 Å. $O_4(OH)_2$	14·34 Å. $(OH)_6$	9·26 Å. $O_4(OH)_2$
Si_3Al	Si_3Al	Si_3Al	Si_3Al	O_6	Si_4
O_6	O_6	O_6	O_6	Si_4	O_6
K_2	$(OH)_6$	$(OH)_6$	K_2	$O_4(OH)_2$	↓ O_6
↓ O_6	Mg_4Al_2	Li_2Al_4	↓ O_6	Al_4	
	$(OH)_6$	$(OH)_6$		$(OH)_6$	
	↓ O_6	↓ O_6		↓ O_6	

one of aluminium. The probable sequence of layers for cookeite $[Al_2Si_3AlO_{10}(OH)_2]^{-1}$ a muscovite-like layer, and $[LiAl_2(OH)_6]^{+}$ a bbsite-like layer containing lithium. The detailed sequence of the oms along the c-axis of phlogopite, chlorite, cookeite, dickite, and lc (table IV) shows the relationship of these minerals still more early. Cookeite is to be regarded as a distinct species, and more osely related to the chlorite group than to the micas, talc, or the

[1] R. C. McMurchy, Zeits. Krist., 1934, vol. 88, p. 420. [M.A. 6–45.]

[2] W. W. Jackson and J. West. Zeits. Krist., 1930, vol. 76, p. 211. [M.A. 467.]

clay minerals. This conclusion is in agreement with the views o Penfield and Hallimond,[1] and depends not only upon physical an chemical data but upon evidence of its formation. Some of th specimens of cookeite from Maine may support the view that it i an alteration product of lepidolite, tourmaline, or spodumene; bu others, particularly those from Buckfield, Ogofau, and Columbi river, show that cookeite undoubtedly occurs as a primary mineral.

Hydromuscovite.

The material analysed by Miss H. Bennett, M.A., B.Sc., comprises

Variety A. A soft, silver-white variety occurring as delicat membranous flakes in narrow veinlets exposed in the surface-workin marked 'Clochdy Gwenno', where it is associated with quart coarsely crystalline pyrite and arsenopyrite.

Table V. Chemical analyses of hydromuscovite (and hydrobiotite).

	A.	B.	C.	D.
SiO_2	46·54	48·39	44·81	41·54
TiO_2	0·17	0·11	0·24	1·90
Al_2O_3	36·37	34·64	35·26	16·55
Fe_2O_3	0·72	1·15	0·63	12·10
FeO	0·36	0·27	0·79	2·49
MnO	nil	nil	0·01	0·18
MgO	0·50	0·44	0·52	9·19
CaO	0·22	0·26	0·22	2·35
Na_2O	0·46	0·22	0·76	1·35
K_2O	8·06	7·82	7·64	4·48
Li_2O	trace	trace	n.d.	—
H_2O (above 105°)	6·31	6·07	8·40	7·63
H_2O (below 105°)	0·52	0·44	0·75	n.d.
P_2O_5	0·06	0·06	trace	—
F	0·02	0·06	n.d.	n.d.
CO_2	nil	nil	nil	—
	100·31	99·93	100·03	99·76
Less O = F ...	0·01	0·03		
	100·30	99·90		

Variety B. A pale, prase-green, wax-like variety occurring as veneer on shear-planes traversing an ore-body on the 420-foot le in the mine.

Variety C. Mica separated from the same source as variety and treated with KCl solution in the manner described on p. 518.

[1] A. F. Hallimond, Min. Mag., 1925, vol. 20, p. 305.

D. Hydrobiotite, deep orange-brown, from biotitized amphibolite, Hayslad quarry, West Malvern.

For mica A, β 1·575, γ 1·580 (sodium-light), sp. gr. 2·65 ± 0·02. Corresponding values for mica B are within the range approximated for mica A. Unit-cell dimensions determined on mica A are a 5·185, b 9·025, $c \sin \beta$ 20·20 Å.

These values agree closely with those determined by Jackson and West (1930) for muscovite: a 5·18, b 9·02, $c \sin \beta$ 19·95 A. The greater c-spacing in the hydromuscovite is related to the high hydroxyl content discussed below (p. 518). McMurchy (loc. cit.) has made a similar observation with regard to chlorites, which show a greater variation in respect of both c-spacing and hydroxyl content.

TABLE VI. Recalculation of analysis A of hydromuscovite.

		%.	Atomic proportions: Oxygen and fluorine.	Other elements.			Metals and silicon to basis $(O,OH,F)_{48}$.
SiO_2	...	46·54	1·5498	0·7749	Si	...	12·00
Al_2O_3	...	36·37	1·0703	0·7135	Al	...	11·06
Fe_2O_3	...	0·72	0·0135	0·0090	Fe'''	...	0·14
FeO	...	0·36	0·0050	0·0050	Fe''	...	0·08
MgO	...	0·50	0·0124	0·0124	Mg	...	0·20
CaO	...	0·15	0·0026	0·0026	Ca	...	0·04
Na_2O	...	0·46	0·0074	0·0148	Na	...	0·22
K_2O	...	8·06	0·0856	0·1712	K	...	2·66
H_2O+	...	6·31	0·3502	0·7005	H	...	10·86
			3·0968				
	...	0·02	0·0011	—	F	...	0·02
			3·0979				

As the two micas A and B contain inclusions of extremely minute needles identified as rutile, the TiO_2 content in each case is ignored in computing formulae. So also is the small P_2O_5 content, which has been traced to dust-like inclusions referred to apatite. The usual analytical figures for water do not discriminate between hydroxyl and molecular water. There is warrant, however, for continuing to treat water above 105° C. as affording an approximate measure of (OH) content.

By computation from the analytical data, specific gravity, and unit-cell dimensions, it is demonstrable that in the muscovite cell the total number of (OH) groups, F atoms, and O atoms independent of hydroxyl rounds off to 48; that is to say, $(O,OH,F)_{48}$ is a constant which is characteristic of muscovite. For micas A and B in particular,

the computed totals are 47·4 and 47·5 respectively. The fact th these totals fall below 48 suggests that none of the water abo 105° C. is either mechanically held or adsorbed along crystal surfac Assuming $(O,OH,F)_{48}$ to be a constant, it follows that if F shows significant variation, (OH) and O can vary reciprocally. Hen variation with respect to (OH) must involve departure from t standard O_{40} required for the generalized muscovite formu $(OH)_8K_4Al_8(Si_{12}Al_4)O_{40}$. The treatment (table VI, p. 517) of t analytical data for mica A illustrates the method of computing muscovite formula to the basis of $(O,OH,F)_{48}$.

The formula thus derived for mica A, together with the formul for micas B, C, and D, are compared with the ideal muscov formula in table VII.

TABLE VII. Atomic contents of hydromuscovite and hydrobiotite.

Ideal muscovite.			A.		B.		C.		D.	
K_4	...	K	2·66	2·88	2·58	2·68	2·48	2·86	1·54	2·
		Na	0·22		0·10		0·38		0·70	
		Ca	0·04		0·06		0·06		0·68	
		Mg	0·20		0·16		0·20		3·70	
		Mn	—		—		—		0·04	
Al_8	...	Fe″	0·08	7·52	0·08	7·54	0·16	6·60	0·56	8·
		Fe‴	0·14		0·22		0·12		2·46	
		Ti	—		—		—		0·38	
		Al	7·06		7·02		6·06		0·52	
$(Si_{12}Al_4)$	...	Al	4·00	16·00	3·52	16·00	4·56	16·00	4·76	16
		Si	12·00		12·48		11·44		11·24	
O_{40}	...	O	37·12	48·00	37·52	48·00	33·70	48·00	34·22	48
$(OH,F)_8$	...	(OH)	10·86		10·44		14·30		13·78	
		F	0·02		0·04		—		—	

The two micas A and B diverge from the ideal muscovite con tution in the following respects:

(*a*) The proportion of hydroxyl groups is high.

(*b*) The total of the atoms in place of the standard K_4 is low.

(*c*) The atom-assemblage corresponding to the standard Al_8 also low.

Features (*a*) and (*c*) are accentuated in the case of mica C, wh is a variety of mica A modified by experimental treatment to det mine its base-exchange capacity as follows: A quantity of the m was immersed in N/20 solution of potassium chloride for 120 ho at room-temperature (25–28° C.), and after being thoroughly wash

vith hot distilled water was analysed by Miss H. Bennett, who ound that water above 105° C. was nearly 36 % higher than in nica A.

The term 'hydromica' lacks precise definition. In the case of he Ogofau micas, the modification of the $(OH)_8K_4$ group in the irection $(OH)_{8+m}K_{4-n}$ is considerable, and is accompanied by modifiation of the standard Al_8 in the direction Al_{8-p}. This divergence rom standard muscovite is accompanied also by change in physical roperties towards those characteristic of the clay species. The uthors suggest that the Ogofau micas might serve, provisionally, as he type to which the description 'hydromuscovite' is applicable; nd 'hydrobiotite' would also be illustrated by the constitution, iven under D in table VII.

The character and extent of the modification in any particular ase is probably determined by the growth conditions and subsequent istory of the mica. The Ogofau hydromuscovite is clearly the oduct of a low-temperature hydrothermal (magmatic) phase of ineralization, and the cookeite is referred to a similar phase.

A lode facies such as that described on pp. 507-510 (exclusive of ookeite) is commonly in genetic relationship to igneous rocks of ranitic or granodioritic composition. The probability that the gofau ore-bodies are so related is further suggested by the occurnce of cookeite and the increased abundance of this mineral in e deeper levels of the mine. But no igneous rocks consistent with is relationship are exposed in the immediate district, though surface dications of mineralization similar to that at Ogofau occur sporadially over a considerable area.

The senior author makes grateful acknowledgement of courtesy nd facilities afforded him at the mine by Commander A. T. L. Vilson and his co-directors of Roman Deep Holdings, Ltd., and to r. A. R. Wadeson, resident manager.

Explanation of Plate XIX.

The Laue photographs were taken with 'white' X-radiation from a tungs target using an intensifying screen. The crystal-plate distance for figs. 1 an is 3 cm.

The rotation photographs of single flakes or flaky aggregates, figs. 3 to 9, w all taken with unfiltered CuK_α radiation, $\lambda = 1{\cdot}539$ Å., in the same cylindri camera, diameter 6·04 cm. A length of 10 cm. on both the original Laue a rotation photographic films is equivalent to 10 cm. on the reproduced figures

Fig. 1. Laue photograph of cookeite from Ogofau, Pumpsaint, Carmarth shire, along the c [001] axis; a [100] axis vertical.

Fig. 2. Laue photograph of cookeite from Ogofau along the c [001] ax a [100] axis vertical. An imperfect alinement of the individual crystals revealed.

Fig. 3. Clinochlore about the b [010] axis.

Fig. 4. Rotation photograph of cookeite from Ogofau about the b [010] axi

Fig. 5. Rotation photograph of cookeite from Hebron, Oxford Co., Maine, approximately about the b [010] axis.

Fig. 6. Muscovitè about the b [010] axis.

Fig. 7. Dickite about the a [100] axis.

Fig. 8. Nacrite about the a [100] axis.

Fig. 9. Lepidolite about the b [010] axis.

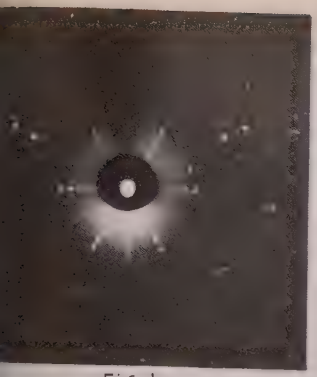

Fig. 1.

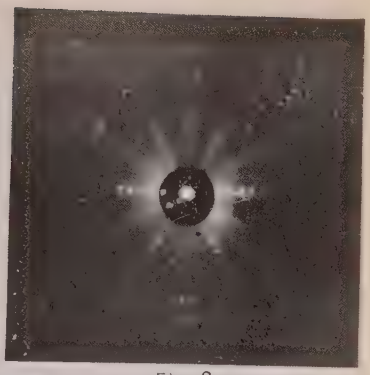

Fig. 2.

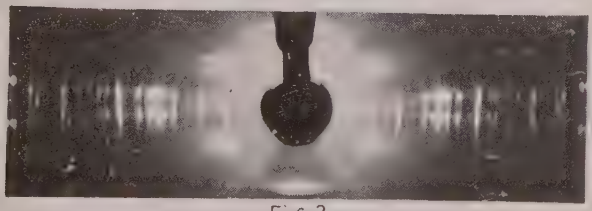

Fig. 3.

Fig. 4.

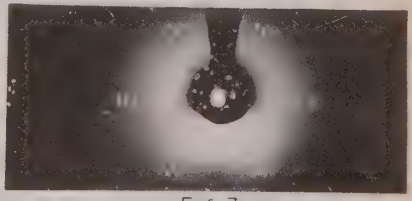

Fig. 7.

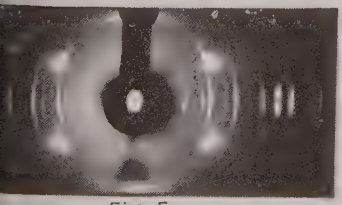

Fig. 5.

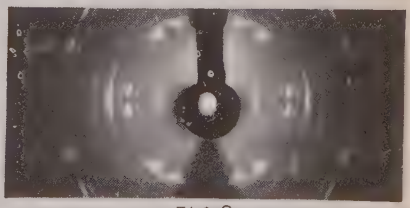

Fig. 8.

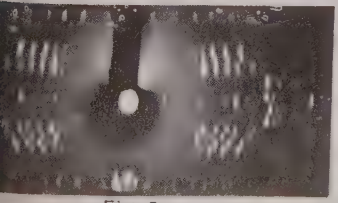

Fig. 6.

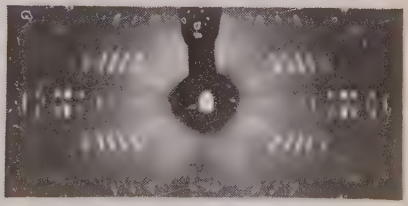

Fig. 9.

F. A. Bannister: X-Ray Photographs of Cookeite and Related Minerals

X-ray studies on pyrolusite (including polianite) and psilomelane.

By George Vaux, B.Sc., F.R.G.S.
With chemical analyses by Miss Hilda Bennett, M.A., B.Sc.

[Read March 26, 1936.]

ONE of the most promising uses of X-ray diffraction methods in mineralogy is the study of those minerals which are opaque and hose crystals are extremely minute. Although recent methods of e examination by reflected polarized light have given valuable in-rmation about these substances, their application to soft, powdery aterials is extremely difficult, an objection which does not apply to -ray methods.

Pyrolusite (including polianite).—The present study had for its main jective an attempt to settle, by X-ray examination, the uncertainty isting as to the relationship between polianite and pyrolusite. rk already carried out by St. Johns [1] has suggested that polianite d pyrolusite are identical, since they have the same cell sides as und from powder photographs. Breithaupt [2] himself, who first ve the name polianite to the mineral from Platten, insisted that lianite and pyrolusite are not independent species, reserving the tter name for pseudomorphous powdery specimens.

Single-crystal photographs were taken about the *c*-axis from ecimens of polianite from Platten, Bohemia, and of pyrolusite from lgersburg, Thuringia. These photographs are absolutely identical, e corresponding spots being the same in position, characteristics, d relative intensity. However, the spots are not sharp and are ways quite broad, indicating that what are, to the eye, single ystals are in reality groups of fibres. In most specimens of pyro-site the fibres are oriented parallel to the *c*-axis only. This fact ould lead to the conclusion that the material consists of very small ystals with large surface area, hence accounting for the high catalyt-c activity exhibited by preparations of manganese dioxide. Crystals

[1] A. St. Johns, Physical Rev., 1923, vol. 21, p. 389.
[2] A. Breithaupt, Ann. Phys. Chem. (Poggendorff), 1844, vol. 61, p. 191.

of polianite also give broad spots, but otherwise behave as sin crystals. It was quite fortunate that for the present work mate was available from the original specimens, both polianite descril by Dana and Penfield[1] from Platten, Bohemia, and the Elgersb material originally described and named pyrolusite by Haidinger 1827. In this way it was possible to establish definitely the abo mentioned identity of these two minerals.

Hitherto it has been customary to use two mineral names crystallized MnO_2: polianite for the well-formed tetragonal cryst isomorphous with minerals of the rutile group; and pyrolusite the fibrous material, some of which is definitely pseudomorph after manganite. In the writer's view polianite should no longer used, since pyrolusite is the older and better name. The fact t fibrous specimens do not conform accurately to the formula Mn and hence are possibly mixed with small quantities of other miner does not in itself constitute a sufficient reason for employing t mineral names. Pyrolusite should be retained as the name both single crystals and for fibrous material of tetragonal MnO_2, isom phous with rutile.

It was also found that many specimens of compact mangan ore, originally labelled psilomelane, give powder photographs ide cal with that of pyrolusite. A specimen (B.M. 91116) label varvicite from Ilfeld, Harz, was also examined and proved to pyrolusite; and the partial analyses made by Phillips and Turn suggest an impure pyrolusite.

Psilomelane.—This mineral was also first described by Haiding who gave the name to the botryoidal material from Schneeberg, Saxo He was of the opinion that Turner's chemical analysis of this mate corresponded to a mixture and not to one mineral; and it was until Fermor's[5] discovery and description of hollandite in 1906 t

[1] E. S. Dana and S. L. Penfield, Amer. Journ. Sci., 1888, ser. 3, vol. p. 243. X-ray photographs were obtained from the specimen, a crystal i which is figured in Dana, Syst. Min., 6th edit., 1892, p. 236, fig. 1. In addit identical X-ray photographs were obtained from B.M. 21987, also from Plat in the British Museum collection.

[2] W. Haidinger, Trans. Roy. Soc. Edinburgh, 1831, vol. 11, p. 136. A por of the type specimen, B.M. 91106, was fortunately available in the Br Museum collection, and was photographed.

[3] R. Phillips and E. Turner, Phil. Mag., 1829, vol. 6, p. 281; 1830, vol. 7, p.

[4] W. Haidinger, Trans. Roy. Soc. Edinburgh, 1831, vol. 11, p. 129.

[5] L. L. Fermor, Trans. Mining and Geol. Inst. India, 1906, vol. 1, p. Records Geol. Surv. India, 1917, vol. 48, p. 103. [M.A. 1–45.]

ny certain evidence existed that both barium and manganese are resent in one and the same mineral. During the early period of he present investigation a specimen (no. 4181) was found in the Brooke collection at Cambridge which was labelled polianite from Platten. This material consists of small plates encrusted over a otryoidal matrix, differing considerably from the material labelled olianite in the British Museum. Upon examination by X-rays it as found not only to be orthorhombic, but also to have an entirely ifferent cell size. At a later date a similar specimen was discovered i the collections of the Academy of Natural Sciences of Philadelphia, nd an examination of a polished section of the latter specimen showed hat there is no apparent difference between the crystalline crust and nternal compact material. This specimen was labelled as having me from Schneeberg, Saxony. Further X-ray examination of both f these specimens, both by crystal and powder photographs, showed em to be identical, as well as being distinct from pyrolusite. By eans of powder methods these specimens were then compared with veral compact specimens in the British Museum labelled psilome- ne (analyses 1, 2, and 3 in table I), and were found to be in perfect greement.

In endeavouring to discover why these specimens were labelled blianite an interesting point suggests itself. Apparently these two ecimens in reality came from Schneeberg, but the label of the one hich went to Cambridge was altered owing to the fact that some one termined the mineral as being polianite, and hence came to the nclusion that if it were polianite it must have come from Platten. ne specimen in the Academy of Natural Sciences, whilst being called olianite, still kept its true locality of Schneeberg. A specimen belled leptonematite from Schneeberg, in the British Museum, has en found to be the same material, and adds corroborative evidence the view that this material did really come originally from that cality.

Chemical analysis of this material establishes its identity with e psilomelane originally described by Haidinger and analysed by rner. Moreover, chemical analyses by Gorgeu,[1] Zambonini,[2] and hers suggest that psilomelane from Romanèche is identical with e Schneeberg material, and this assumption has been proved to

[1] A. Gorgeu, Bull. Soc. Franç. Min., 1890, vol. 13, p. 21.

[2] F. Zambonini and V. Caglioti, Periodico Min. Roma, 1931, vol. 2, p. 73.

be correct by powder photographs of psilomelanes from the form locality (B.M. 1906, 249), showing perfect agreement with those

TABLE I. Chemical analyses of Psilomelane.

	1.	2.	3.	4.	5.
MnO_2 ...	66·62	66·73	70·38	68·00	66·98
MnO ...	7·09	7·12	7·90	10·70	10·18
BaO ...	17·46	17·48	12·38	15·73	16·36
SiO_2 ...	0·52	0·51	0·09	0·59	0·26
TiO_2 ...	nil	nil	nil	—	—
Al_2O_3 ...	0·37	0·35	0·73	—	—
Fe_2O_3 ...	0·15	0·20	0·18	0·30	—
CaO ...	0·19	0·26	0·66	—	—
MgO ...	0·15	0·13	0·13	0·30	—
Na_2O ...	trace	trace	trace	0·02	—
K_2O ...	trace	trace	0·42	0·08	—
Li_2O ...	trace	trace	trace	—	—
CuO ...	0·48	0·31	0·38	trace	—
NiO ...	trace	trace	0·03	trace	—
CoO ...	0·90	1·00	0·48	—	—
WO_3 ...	0·89	0·68	—	0·28	—
H_2O+ ...	4·38	4·41	4·18	3·82	6·22
H_2O- ...	0·48	0·50	1·88	0·48	
	99·68	99·68	99·82	100·30	100·00
Sp. gr. ...	4·71	—	—	4·697	—

Number of atoms in the unit cell per 20 oxygen atoms.

Mn^{iv} ...	7·60	7·60	7·83	7·69	7·21
Mn'' ...	0·99	0·99	1·08	1·48	1·35
Ba ...	1·13	1·13	0·78	1·01	1·00
Ca ...	0·03	0·05	0·11	—	—
Mg ...	0·04	0·03	0·03	0·07	—
Cu ...	0·06	0·04	0·05	—	—
Co ...	0·12	0·13	0·06	—	—
H_2O ...	2·41	2·42	2·24	2·08	3·22
ΣRO ...	2·37	2·37	2·11	2·56	2·35

1. 'Leptonematite', Schneeberg, Saxony. (B.M. 69160.)

2. 'Leptonematite', Spitzleite, Eibenstock, Saxony. (B.M. 32687.)

3. Psilomelane, Restormel iron mine, Lostwithiel, Cornwall. (B.M. 27: Analyses 1–3 by Miss H. Bennett.

4. 'Polianite', Schneeberg, Saxony. Specimen in the Academy of Nat Sciences, Philadelphia. Analyst, H. J. Hallowell. The analysis as repo gives MnO_2 62·80, MnO 10·70, oxygen 5·20 %. Since 5·20 % oxygen corresp closely to 62·80 % Mn_2O_3, it has been assumed that the figures shoul MnO_2 62·80 + 5·20 = 68·00, MnO 10·70 %.

5. Psilomelane, Schneeberg, Saxony. Analyst, E. Turner, Trans. Roy. Edinburgh, 1831, vol. 11, p. 172.

specimens from the latter. Sufficient evidence is therefore available to retain the name psilomelane for this material.

An interesting feature of various published analyses of psilomelanes is the fact that they contain varying amounts of barium, but the amount present never exceeds about 17 % BaO. This fact bears out the original theory of Haidinger, as expressed above, that there are many impurities present in many of the psilomelanes, thus accounting for the wide variation in the BaO content; but the fact which Haidinger overlooked was that psilomelane in its pure form has a definite chemical formula. In view of these facts it would seem improper to apply the name psilomelane to manganese minerals which contain 17 % BaO.

For the density of psilomelane, only values obtained on analysed material can be accepted. Apart from Haidinger's original value of 4·004–4·079, three figures are available: Turner found 4·365 for Romanèche material; E. E. Schmid[1] 4·31 for material from Elgersburg; and L. L. Fermor[2] 4·54 for material from Tekrasai, Bengal. For the material of analysis 4, H. J. Hallowell reports a density of 4·697; a careful determination on the specimen B.M. 69160 (analysis 1) gave D_4^{20} 4·71 ± 0·01. From this value, the analysis, and the unit cell size, the number of oxygen atoms per unit cell is found to be 20·53 ± 0·7. Accepting this as an approximation to 20, the atomic proportions per 20 oxygen for the four new analyses and for Turner's original analysis have been calculated, omitting SiO_2, Al_2O_3, Fe_2O_3, WO_3, and alkalis, and are included in table I. The ideal formula is evidently $H_4R_2Mn_8O_{20}$, where R includes the divalent metals Mn, Mg, Ca, Ni, Co, and Cu; but there is a noticeable excess of RO and a corresponding deficiency of Mn^{IV}.

One of the Cambridge specimens of this material also carries small crystals of pyrolusite which can be distinguished readily from the true psilomelane by X-ray photographs. This might lead to the confusion that there is frequently a varying amount of pyrolusite material included in any specimen from these localities, and its presence would obviously account for the discrepancies in the analyses, as varying amounts of pyrolusite would cause the barium oxide content of the whole to differ radically. This gives a very good example of the importance of carrying out X-ray examinations, along with other means of identification, for material which has only been

[1] E. E. Schmid, Ann. Phys. Chem. (Poggendorff), 1865, vol. 126, p. 154.
[2] L. L. Fermor, Mem. Geol. Surv. India, 1909, vol. 37, p. 100.

analysed, as any impurities present can be detected with gre ease.

Table II gives a comparison of the symmetry and cell dimensio of the minerals discussed above, together with those of other mang nese minerals which have been determined by other workers. interesting feature of this comparison is the fact, first noticed J. D. Bernal, that a simple relation exists between the cell dimensio of psilomelane, pyrolusite, and manganite. In the table this i

TABLE II. X-ray data for manganese oxide minerals.

Mineral.	System.	Cell-sides: *a*.	*b*.	*c*.	Rat
1. Pyrolusite	Tetragonal	4·38	4·38	2·86	1 1
2. Psilomelane	Orthorhombic ...	9·1	13·7	2·86	2 3
3. Manganite	Orthorhombic ...	8·84	5·23	5·74	2 1
4. Braunite	Tetragonal	13·28	13·28	18·58	3 3
5. Artif. Mn_2O_3	Cubic	9·41	9·41	9·41	2 2
6. Hausmannite	Tetragonal	8·14	8·14	9·42	2 2

1, 2. New data.

3. J. Garrido, Bull. Soc. Franç. Min., 1935, vol. 58, p. 224. [M.A. 6–176.]

4. G. Aminoff, Kungl. Svenska Vetenskapsakad. Handl., 1931, ser. 3, vo no. 5, p. 14. [M.A. 4–461.]

5. R. W. G. Wyckoff, The structure of crystals, 2nd edit., 1931, p. 254.

6. G. Aminoff, Zeits. Krist., 1926, vol. 64, pp. 475–490. [M.A. 3–342.]

has been carried further so as to include other manganese miner which have been added for comparison. These figures present obvious explanation for the intimate intergrowth of the manga oxides. As the values for the *c*-axis are in some cases the sa this seems to be the most permanent value for these minerals, the variations in cell size have taken place along the other two a The fact that dimensions along the *a*- and *b*-axes consist of sim multiples is also interesting in the light of the many pseudomorph changes which occur in these minerals.

This work has been carried on in the laboratory of the Impe College of Science, London, and in the Mineral Department of British Museum, under the direction of Mr. F. A. Bannister. author is also deeply indebted to Dr. G. F. Herbert Smith, Keepe Minerals in the British Museum, and Prof. P. G. H. Boswell. samples of polianite described by Dana were made available thro the courtesy of Prof. W. E. Ford of Yale University.

An iron-rich optically-positive hypersthene from Manchuria.

Kazuo Tsuru, Ryojun College of Engineering, Manchuria,
and N. F. M. Henry, M.A., B.Sc.
Department of Mineralogy and Petrology, Cambridge.

[Read January 28, 1937.]

In a recent paper[1] the occurrence was described of a very iron-rich orthorhombic pyroxene in thermally metamorphosed iron-rich rocks in Manchuria. The crystals are commonly 2–5 cm. in length, but some are larger, and they are accompanied by grunerite, small garnets, and disseminated magnetite. Some of these crystals are optically positive, and the following data were obtained on one crystal.

	Wt. %.	No. of atoms on basis of 6 oxygens.		
SiO_2 ...	45·95	1·975	2·000	
Al_2O_3 ...	0·90	0·046 (0·025 + 0·021)		
TiO_2 ...	0·10	0·003	1·998	(Fe+Mn) as % of (Fe+Mn+Mg) = 88 %.
Fe_2O_3 ...	0·31	0·010		
FeO ...	41·65	1·491		
MnO ...	5·02	0·182		
MgO ...	3·49	0·225		
CaO ...	1·43	0·066		
H_2O+ ...	0·65	—		
H_2O- ...	0·09			
	99·59			Analyst, N. F. M. Henry.
Sp. gr. ...	3·88			

The refractive indices measured (±0·001) in sodium-light are:

α 1·755, β 1·763, γ 1·773, $\gamma - \alpha$ 0·018. 2V 83° ± 2°.

Pleochroism very weak, α yellowish, β and γ greenish. Dispersion very strong, $r > v$ (over γ). The orthorhombic symmetry was verified by X-ray photographs.

The most recent diagram of optic properties in the orthorhombic

[1] K. Tsuru, A remarkable association of several thermal and stress minerals in the Yu hsi kou iron-bearing district. Memoirs of the Ryojun College of Engineering, Manchuria, 1935, vol. 8, no. 8, p. 174.

pyroxenes[1] shows the variation up to 83 % mol. $(Fe+Mn)SiO_3$, l
if these curves are slightly extrapolated it is found that the n
data fall perfectly on to them. The form of the 2V curve in t
region is such that a very small change in the percentage of the e
molecules produces a very large change in the optic axial angle, a
different values of 2V can be obtained from adjacent crystals.
a mineral with 85 % mol. $(Fe+Mn)SiO_3$, $2V = 90°$, and for hig
percentages of this end-molecule the mineral becomes optica
positive. This shows the existence in this series of an optica
positive region which extends to 15 % from the iron end-molec
and which balances the enstatite region at the other end of
series. It is proposed that the name 'orthoferrosilite', put forw
previously (N. F. M. Henry, 1935, p. 225) for the $FeSiO_3$ molec
in this series in analogy with the 'clinoferrosilite' of Bowen, sho
apply also to minerals of this series with up to 15 % mol. MgS
The actual mineral for which data has been given above could t
be described as $En_{12}Of_{88}$.

The discovery of this mineral is of importance for two reas
It shows the existence of an optically positive region exactly co
sponding to the enstatite area and, although it extends our knowle
of the series only 5 % nearer the end-molecule, it does show
approximate correctness of the curves for the various properties
far as these have been drawn. It seems quite probable that
more iron-rich members of this series will be discovered.

A few grains of this mineral were heated in an evacuated si
tube by means of an electric furnace with a thermo-regula
When held at 934° C. for 2½ hours the mineral showed no cha
but when held at 940° C. for the same period of time, each cry
inverted to a disoriented aggregate of coarsely twinned monocl
crystals, exactly as described by N. L. Bowen and J. F. Schai
This temperature is rather lower than would have been expe
from their diagram (loc. cit., p. 164), but the form of the inver
curve (KY) is not very well known in this region, while the e
of other constituents on the inversion point is unknown. The m
clinic form has γ 1·780, which fits on to the curves given by N. L. Bo
and J. F. Schairer (loc. cit., p. 198).

[1] N. F. M. Henry, Some data on the iron-rich hypersthenes. Min. M
1935, vol. 24, pp. 221–226.

[2] N. L. Bowen and J. F. Schairer, The system $MgO-FeO-SiO_2$. A
Journ. Sci., 1935, ser. 5, vol. 29, p. 169. [M.A. 6-352.]

An occurrence of the mineral pumpellyite in the Lake Wakatipu region, western Otago, New Zealand.

By C. Osborne Hutton, M.Sc. (N.Z.), F.G.S.
Shirtcliffe Fellow of the University of New Zealand.
Department of Mineralogy and Petrology,
University of Cambridge.

[Read January 28, 1937.]

PREVIOUS accounts of pumpellyite, a blue-green hydrous silicate of calcium and aluminium, are few in number; the first record is that of Palache and Vassar,[1] who described the mineral after a study of the amygdaloidal rocks of the Keweenaw Peninsula. Later Burbank[2] recorded a very similar occurrence in Haiti, West Indies. Again, it was observed as a constituent of veins cutting glaucophane-schists in California by Irving, Vonsen, and Gonyer,[3] and later by Waldmann[4] at Hochlantsch Mount, Styria, in an altered diabase, and from Lake Enare, Finnish Lapland, where it occurred in altered lime-silicate rocks. Pumpellyite was found by Quitzow[5] in diabase-porphyrites and glaucophane-rocks from the Trias of northern Calabria, Italy. The same writer[6] later observed it in a diabase-porphyrite from Tygirsk, Altai Mts., Siberia; in the Tertiary amygdaloidal basalts at Mormanno, northern Calabria; in diabases and

[1] C. Palache and H. E. Vassar, Some minerals of the Keweenawan copper deposits: pumpellyite, a new mineral; sericite; saponite. Amer. Min., 1925, vol. 10, pp. 412–418. [M.A. 3–8.]

[2] W. S. Burbank, Additional data on the properties of pumpellyite, and its occurrence in the Republic of Haiti, West Indies. Amer. Min., 1927, vol. 12, pp. 421–424. [M.A. 3–454.]

[3] J. Irving, M. Vonsen, and F. A. Gonyer, Pumpellyite from California. Amer. Min., 1932, vol. 17, pp. 338–342. [M.A. 5–233.]

[4] L. Waldmann, Pumpellyit aus Steiermark und Finnisch Lappland. Min. Petr. Mitt. (Tschermak), 1934, vol. 45, pp. 92–93. [M.A. 5–479.]

[5] H. W. Quitzow, Diabas-Porphyrite und Glaukophangesteine in der Trias von Nordkalabrien. Nachr. Gesell. Wiss. Göttingen, math.-phys. Kl., 1935, N.F., vol. 1, no. 9, pp. 83–118.

[6] H. W. Quitzow, Pumpellyit, ein häufiges Hydrothermal- und Sekundärmineral in basischen Gesteinen. Zentr. Min., Abt. A, 1936, pp. 39–46. [M.A. 6–429.]

diabase-tuffs from eastern Corsica; and in diabases from Braunau Waldeck, and several other German localities. Rocks containi the 'green clinozoisite' described by G. Fischer (1929) from Wipp in the Harz, Germany, have on re-examination by Quitzow be found to contain abundant pumpellyite. Finally, Tsuboi[1] recor the mineral in veins traversing the basic igneous rocks of the Mika system in the Titibu district, Japan.

Professor C. E. Tilley pointed out to the present writer th sections of two spilitic dolerites from Nassau, viz. nos. 19,0 (Weilburg, Lahn) and 29,657 (Sinn, south of Herborn, Westerwal in the Harker Collection of the Department of Mineralogy a Petrology, Cambridge, contained pumpellyite, and this mineral af study has proved to be identical with the western Otago mine described below.

Occurrence.—During the last five years the writer has been engag in a study of the Lake Wakatipu region, in western Otago, N Zealand, composed of a varied series of sedimentary and igne rocks which have suffered low-grade dynamothermal metamorphi on a regional scale. The rocks all belong to the zone of chlori but have been subdivided into four subzones according to the deg of reconstitution.[2] The mineral pumpellyite has been identified schists belonging to three of these subzones, viz. Chl. 1, Chl. 2, a Chl. 3, but does not appear to be present in the more metamorpho rocks of the Chl. 4 subzone. In addition pumpellyite is rarely important constituent of numerous narrow quartz-albite segregat veins which cut the schists throughout this region.

Optical properties.—The mineral may occur as tiny prisma yellowish-green crystals (measuring up to 0·3 mm. in length) wit relict clastic grains of plagioclase (now albite), or at least clos associated with this mineral. The prisms are rarely terminated, instead often have a distinctly ragged or frayed appearance (fig. 1 In other slices it has a finely fibrous aspect when it builds up f like aggregates which appear distinctly granular under a low magn cation. Such 'granules' have a most characteristic appearance to the lack of any common orientation of the fibres, portions of grains being green while others are yellow. In the best exam

[1] S. Tsuboi, Petrological notes. Japanese Journ. Geol. Geogr., 1936, vol. pp. 333–337.

[2] C. O. Hutton and F. J. Turner, Metamorphic zones in north-west Ot Trans. Roy. Soc. New Zealand, 1936, vol. 65, pp. 405–406.

(no. 3471) so far examined the mineral occurs as a felt of minute prisms as well as in distinct crystals averaging 0·2 mm. in length (fig. 1 A).

Fig. 1 A. Pumpellyite showing prismatic and 'granular' form, in quartz-albite vein, no. 3471.

Fig. 1 B. An 'auge' of crystalloblastic albite and pumpellyite in schistose greywacke, no. 3172.

Colour varies from a very pale green to a distinct bluish-green, rarely brown. Pleochroism is strong in deeply coloured varieties according to the scheme: α colourless or very pale yellow, β strong bluish-green, γ colourless or very pale yellow. The intensity of absorption being $\beta > \alpha = \gamma$. The optic axial angle is very small, possibly not exceeding 10°,[1] while the sign is positive (determined in section no. 3172), but the determination of the sign was difficult owing to the lack of suitably oriented crystals. The refractive indices obtained by immersion in oils are as follows: α 1·678, β 1·681, γ 1·688 $\pm$ 0·002, $\gamma - \alpha$ 0·010. Another determination gave β 1·684. Although the birefringence in this case is approximately equal to that of quartz, brownish-purple or bluish anomalous interference-tints were detected in some instances, the result of a

[1] Not observed on specimen of determined refractive index.

combination of low birefringence and strong dispersion. The dispe
sion appears to be $r < v$. β is parallel to the length of the crysta
hence they may have either positive or negative elongation; t
direction of maximum absorption, however, is always parallel to t
long axis of the crystals. Traces of a cleavage may occasionally

		A.	B.	C.	D.	E.
Refract. indices	α ...	1·678	1·698	1·700	1·678	1·677
	β ...	1·681	1·700	1·707	1·680	1·678
	γ ...	1·688	1·708	1·718	1·692	1·690
Optic sign ...		positive	positive	positive	positive	positiv
Dispersion		$r<v$	$r<v$	$r<v$	$r<v$	$r<v$
2V		small	large	75–80°	40°	38°
Orientation		$\beta = b$	$\beta = b$	$\beta = b$	$\beta = b$	$\beta = b$
Colour ...		green, rarely brown	green	green	green	brown
Pleochroism	α ...	colourless to very pale yellow	colourless	colourless	colourless	colour
	β ...	bluish-green	bluish-green	bluish-green	pale green	brown yello
	γ ...	colourless to very pale yellow	colourless	colourless	colourless	colour

		F.	G.	H.	I.
Refract. indices	α ...	—	—	—	1·686
	β ...	1·69	1·68 1·69	—	1·690
	γ ...	—	—	—	1·698
Optic sign ...		positive	positive	negative	positive
Dispersion		$r<v$	$r<v$	$r>v$	$r<v$
2V		variable	40°	nearly 0°	36–40°
Orientation		$\beta = b$	$\beta = b$	$\beta = b$	$\beta = b$
Colour ...		bluish-green	green	green	chromium-gr
Pleochroism.	α ...	nearly colourless	colourless	usual pleochroism	almost colou
	β ...	bright bluish-green	green	,,	light ocean-g
	γ ...	nearly colourless	colourless	,,	almost colou

A. Lake Wakatipu, western Otago, New Zealand.
B. Keweenaw Peninsula, Michigan. Palache and Vassar, 1925.
C. Haiti, West Indies. Burbank, 1927.
D. Mill Creek, California. Irving, Vonsen, and Gonyer, 1932.
E. Skaggs, California. Irving, Vonsen, and Gonyer, 1932.
F. Lapland. Waldmann, 1934.
G. Calabria, Italy. Quitzow, 1935.
H. Braunau, Waldeck, Germany. Quitzow, 1936.
I. Asahine, Titibu-gôri, Saitama prefecture, Japan. Tsuboi, 1936.

developed parallel to the β vibration-direction in the crystals (fig. 1 B).

A comparison of the properties of the Otago mineral with those of other occurrences is made above, and it will be seen that they do not show any great variation. The blue-green colour for the β vibration-direction appears to be characteristic of the mineral, with brown tints rare. In this connexion might be mentioned the occurrence described by Fischer (Quitzow, loc. cit., pp. 41–42) of aggregates of radiating crystals with one end of the crystals red, while the other is bluish-green, and have the properties of pumpellyite.

Paragenesis and origin.—It is important to note here that Quitzow has observed the following facts:

1. The close association of calcic plagioclase and pumpellyite.
2. That pumpellyite is characteristic of the first depth zone.
3. The early appearance of pumpellyite, often before epidote.

In western Otago the mineral is commonly closely associated with plagioclase in the greywackes and their sheared equivalents, or rarely in quartz-albite veins. This plagioclase was originally a calcic variety, probably andesine or labradorite, but shearing has brought about a recrystallization to albite, the anorthite molecule being represented now either by clinozoisite or epidote, or by pumpellyite. In the more highly metamorphosed rocks of this region (those belonging to the Chl. 4 subzone), where the plagioclase relicts have become completely broken down and recrystallized into a mosaic of albite grains, pumpellyite does not occur, its place being taken by epidote or clinozoisite.

The presence of pumpellyite in narrow quartz-albite veins is suggestive of a segregation by solutions of the pumpellyite molecule, as is so frequently the case with epidote.

The writer wishes to thank Professor C. E. Tilley for his advice and criticism in connexion with this paper.

An interesting occurrence of lawsonite in glaucophane bearing rocks from New Caledonia.

By Germaine A. Joplin, B.Sc., Ph.D.
Department of Geology, University of Sydney.

[Read January 28, 1937.]

THE writer has recently described a small collection of glauc phane-schists from the Diahot valley and the north-east coast New Caledonia (Jensen, 1936), and four of these contain lawsoni

Lacroix (1897) has recorded lawsonite from New Caledonia, b the occurrence seems worthy of further mention as in two cases t lawsonite is found to be pseudomorphing plagioclase in doleri rocks which show a relict ophitic fabric. So far as the writer aware, such an occurrence of lawsonite pseudomorphing felspar h not been recorded, though Lacroix figures a glaucophane-schist fr Corsica which suggests this structure. The other two lawsoni bearing rocks from New Caledonia seem to have been coarse-grai plutonic rocks and probably never had an ophitic fabric.

The lawsonite occurs as small stumpy prisms or as tabular cryst (0·075 mm.), which are aggregated and completely replace laths plagioclase which measure up to about 0·5 mm. in length. T mineral is optically positive, α' 1·665, γ' 1·681, and a faint blu colour is noticeable in the rock powder. Three cleavages are develop —a fairly perfect (010) and a less perfect (110) and (001). In plutonic rocks the lawsonite crystals are a little larger and cleavage is better shown (fig. 1 B).

Original augite is present in all the glaucophane-lawsonite-ro and the relation of this mineral to the lawsonite pseudomorphs in cates a blastophitic structure (fig. 1 A). In the plutonic rocks augite crystals measure up to 6 mm. and show alteration to chlo and glaucophane.

Glaucophane occurs as fibrous prisms in a ground of lawsonite as threads interlaced with augite. In the two plutonic rocks l prisms of glaucophane show a slight radial arrangement.

In the collection of glaucophane-schists described for Dr. Jen

there are a number that contain epidote or clinozoisite, but neither of these minerals occurs in the lawsonite-bearing assemblage. Moreover, no original augite is present in the epidote- or clinozoisite-bearing types.

Fig. 1 A. Glaucophane-lawsonite-rock showing original augite and a blastophitic structure. The felspar is entirely replaced by small tabular crystals of lawsonite and the glaucophane occurs as long prisms, the somewhat parallel arrangement of which suggests a slight schistosity. The rock is an altered dolerite. × 18¼.

Fig. 1 B. Glaucophane-lawsonite-rock showing rectangular sections of lawsonite and long prisms of glaucophane in a ground of chlorite and albite. The clear areas near the top of the figure are albite. Large crystals of pyroxene, altering to chlorite, occur elsewhere in the slide. The rock appears to have been a coarse gabbro. × 37.

Three points of interest relating to the grade of metamorphism, to the genesis of the mineral, and to the origin of the rock arise out of the paragenesis of the lawsonite.

First, the blastophitic structure and the occurrence of primary augite in the lawsonite-bearing rock would indicate that the metamorphism was low-grade.

Secondly, the fact that the lawsonite is pseudomorphing the plagioclase laths would indicate that it arose directly from anorthite, though there must have been an addition of lime, possibly from

augite, since there is no diminution in volume after the removal the albite molecule. J. P. Smith (1906, p. 208) has described la sonite included in and fringing plagioclase and suggests that it v derived from anorthite. Further, it is significant that the lawson is not associated with epidote, which would seem to indicate that latter took the place of lawsonite under higher grade conditions, suggested by Harker (1932). A lawsonite-garnet-glaucophane-r is recorded from California by J. P. Smith (1906, p. 220), but thi possibly in unstable equilibrium.

Thirdly, the lawsonite pseudomorphs point to a fairly high an thite content in the original felspar, even if addition of lime be pos lated, and therefore to a calcic rather than to an alkaline ro Washington (1901) has tabulated a number of analyses of glau phane-bearing rocks and subdivides his Basic Group into rocks wh contain from 4·4 to 5·8 % of CaO and those which contain from 1·1 to 1· of CaO. Reference to this table also shows that Na_2O is usua higher in the lime-poor group, and this would suggest that the ro were originally alkaline types or deuterically altered calcic ro There is nothing to indicate an alkaline rock, however, in those ty that contain high lime, and it would seem evident that glaucoph assemblages could arise from both an alkaline and a calcic r although it is tacitly implied by Harker (1932) that they may or nate only by the metamorphism of alkaline rocks or by alkali metasomatism.

The Anglesey glaucophane-rocks are generally considered to altered spilites, but if the Na_2O/CaO ratios of the spilites and t supposed metamorphic equivalents be compared (Greenly, 191 is at once apparent that lime is much higher in the metamorphic ro

Spilites	Anal. I, p. 74 Na_2O/CaO 1/2·7	Schists	Anal. I, p. 117 Na_2O/CaO 1/4·4
	Anal. II, p. 74 Na_2O/CaO 1/2·0		Anal. II, p. 117 Na_2O/CaO 1/5·3

The field evidence upon which these rocks are compared is a slender. In one instance Greenly states that a glaucophane-sc may be traced into a chlorite-epidote-albite-schist 'which differs no way from those that are known to be derived from spilitic la and albite-diabases'. This is surely a dangerous correlation w chlorite-epidote-albite-schist is such a common type and may be derived by the low-grade metamorphism of a normal basic r (Harker, 1932, p. 279).

The present writer would therefore suggest that glaucophane-schists may be derived from both alkaline and calcic rocks, and that the lawsonite-glaucophane assemblage probably stands in the same relation to calcic rocks as does the well-known epidote-albite assemblage.

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1895 F. L. Ransome, On lawsonite: a new rock-forming mineral from Tiburon Pen., California. Univ. Calif. Bull. Dept. Geol., vol. 1, no. 10, p. 301.

1897 A. Lacroix, Sur la lawsonite de Corse et de la Nouvelle-Calédonie. Bull. Soc. Franç. Min., vol. 20, pp. 309–312.

1901 H. S. Washington, A chemical study of the glaucophane schists. Amer. Journ. Sci., ser. 4, vol. 11, pp. 54–55.

1906 J. P. Smith, The paragenesis of the minerals in the glaucophane-bearing rocks of California. Proc. Amer. Phil. Soc., vol. 45, pp. 208, 220.

1919 E. Greenly, The geology of Anglesey. Mem. Geol. Surv. Great Britain, vol. 1, pp. 74, 117–119.

1932 A. Harker, Metamorphism, a study of the transformations of rock-masses. London, pp. 134, 291.

1936 H. I. Jensen, Problems in the geology of New Caledonia. With Appendix: A note on the petrology of a small collection of schists from New Caledonia (pp. 273–276), by G. A. Joplin. Proc. Linn. Soc. N.S.W., vol. 61, pp. 262–276.

The deuteric mineral sequence in the Enoggera granit Queensland.

By Marjorie J. Whitehouse, B.Sc.
Geology Department, University of Queensland.

[Read March 11, 1937; communicated by the President.]

THE Enoggera 'granite', in which occur the minerals to described, is situated a few miles to the west of the city Brisbane, and within the Greater Brisbane area. Deuteric and all minerals have previously been recorded from quarries in the gran by H. C. Richards [1] and W. H. Bryan,[2] and a specimen is recor in the Queensland Mineral Index[3] as 'Heulandite occurring as geo in granite. Loc. Enoggera.' [4]

The granite itself is very varied in character, and Bryan has rec nized two main types, a pink phase and a grey phase. The pink ph approaches an adamellite, while the grey is more granodioritic character. There is, however, every gradation from one type to other due to admixture, and this reaches its maximum in a hyb rock formed presumably by the mingling of the two magmas. The fore, it is obvious that a complete picture of the granite cannot shown by chemical analyses, but those quoted below will give so indication of its general character and of its variety.

There are three quarries in the granite and the minerals have to the present been found only in these. Two are in the pink ph and one in the hybrid rock, and all are close to the contact with Bunya Phyllite division (Ordovician ?) of the Brisbane Schists. minerals occur as veins and infilling cavities, the latter varying fr

[1] H. C. Richards, The building stones of Queensland. Proc. Roy. Queensland, 1918, vol. 30, p. 102.

[2] W. H. Bryan, Geology and petrology of the Enoggera granite and al intrusives. Proc. Roy. Soc. Queensland, 1923, vol. 34 (for 1922), p. 142.

[3] B. Dunstan, Queensland mineral index. Queensland Geol. Surv., 1 publ. no. 241, p. 560.

[4] An examination of this specimen, kindly lent by the Geological Sur shows that the 'heulandite' is in fact laumontite.

a few inches to about two feet across. All occurrences are in the heart of apparently solid blocks of granite, a feature causing much annoyance in the quarrying operations.

Some reaction appears to have taken place between the contents of the vughs and the surrounding rock, resulting in a rough zonal arrangement. In the vughs themselves there is a medley of minerals consisting mainly of zeolites and calcite. These are usually surrounded by a band of pegmatite consisting of quartz and felspar in rough

Analyses of granites from Enoggera, Queensland (W. H. Bryan, 1923).

	Pink Phase.	Hybrid.	Grey Phase.
SiO_2 ...	73·52	71·50	61·10
TiO_2 ...	0·20	0·41	—
Al_2O_3 ...	11·05	14·13	19·24
Fe_2O_3 ...	nil	0·60	4·66
FeO ...	3·15	3·23	—
MgO ...	1·03	1·17	2·56
CaO ...	1·70	2·70	5·25
Na_2O ...	4·08	2·97	3·82
K_2O ...	3·99	2·86	1·68
H_2O+ ...	0·44	0·32	1·31
H_2O- ...	0·16	0·10	0·64
CO_2 ...	—	—	—
P_2O_5 ...	0·15	0·35	—
	99·47	100·34	100·26
Sp. gr. ...	2·58	2·59	2·71

graphic intergrowth. Occasionally, instead of the pegmatite, a zone of greisenized material is found. This grades into the fresh granite. Pegmatite also occurs as sporadic patches in the granite. These contain the normal minerals of the granite and are perfectly fresh and free from miarolitic structure.

It is of interest to note that only in two places have the gases associated with the magma been recorded as having reached beyond the margin. One of these is in the northern part of the mass, where patches of schorl and the tourmaline-albite-rock occur.[1] The other locality is to the south, where, at Finney's Hill, Indooroopilly, argentiferous galena occurs in considerable quantities. Although about a mile from the nearest granite outcrop, L. C. Ball[2] has reported the

[1] W. H. Bryan, An unusual tourmaline-albite rock from Enoggera, Queensland. Proc. Roy. Soc. Queensland, 1924, vol. 35 (for 1923), pp. 48–60.

[2] L. C. Ball, Queensland Government Mining Journ., 1920, vol. 21, pp. 266, 524, 527.

association of this deposit with a line of dikes. Occurring with it are small quantities of copper, bismuth, and zinc ores.

Laumontite.[1]—This is the most abundant zeolite and occurs in vughs and veins as aggregates of comparatively large crystals, occasionally as isolated crystals up to an inch in length, sometimes in radiating groups, or as parallel crystals filling small veins. It occurs either alone or associated with the other minerals; and it is sometimes intergrown with calcite.

The colour varies from white to light red, depending on the percentage of iron present, and is intensified on prominent cleavage lines. The streak is colourless. In the hand-specimens the mineral is opaque. The lustre varies from vitreous to pearly, basal sections being less lustrous than the prismatic. There are three cleavages, two very good ones parallel to (100) and (110), and a third not so well developed parallel to (001). The cleavage is more pronounced in those parts of the crystals which project into the cavities. At their distal ends they are often compact: this changes into a lamellar stage and finally into a splintery stage where both prismatic cleavages are well developed. The hardness varies from 3 in the well-cleaved splintery crystals to 5 in the more compact ones. Specific gravity 2·2 to 2·3.

The optical extinction on cleavage fragments is in part 30° with positive elongation, and in part nearly straight, again with positive elongation. Fragments with straight extinction show a negative biaxial figure with small optic axial angle and the optic axial plane parallel to the elongation near the border of the field. Fragments with 30° extinction do not show definite interference-figures. Refractive indices of cleavage fragments α' 1·508, γ' 1·524 approx.

When heated in a closed tube the mineral gives off water. In the bunsen-burner flame it splinters and glows at the edges, soon losing its pink colour. When heated more strongly with the blowpipe it curls up and fuses with intumescence to form a bead which cools to a white enamel. Treated with strong hydrochloric acid in the cold it dissolves slowly, but in hot hydrochloric acid it decomposes readily, forming a gelatinous mass. It shows a marked efflorescence even at ordinary temperatures.

The following analysis of the laumontite is supplied by courtesy

[1] This description is based largely on a communication from Mr. M. H. of the British Museum of Natural History, to whom some small fragments were submitted.

of the Queensland Government Analyst, to whom samples were submitted.

		Recalculated.
SiO_2 ...	50·96	52·13
TiO_2 ...	nil	nil
Al_2O_3 ...	22·52	23·04
Fe_2O_3 ...	0·20	0·20
MnO ...	nil	nil
MgO ...	trace	trace
CaO ...	12·05	11·85
Na_2O } ...	0·14	0·14
K_2O }		
H_2O+ ...	12·34	12·64
H_2O- ...	1·30	—
CO_2 ...	0·36	—
	99·87	100·00

The material was separated as far as possible from calcite with which it is intergrown, but the 0·36 % CO_2 in the analysis seems to indicate that a little still remained. The modified analysis is calculated free from $CaCO_3$ and moisture.

Gismondite.—This zeolite was found only on one specimen where a few plate-like crystals almost microscopic in size were grown on chlorite. It is colourless, biaxial and negative, and forms double twins united as fourlings.

Prehnite occurs as characteristic globular and hemispherical masses of small radiating crystals. The colour varies from colourless to light green, but the surfaces of the rounded masses are often stained green, brownish, or yellowish. Generally it occurs in the central part of the roughs, associated with the other minerals; but occasionally it is the sole occupant of cavities, where it occurs as masses of elongated crystals lining the walls.

Calcite.—Calcite is one of the most abundant minerals present. The crystals vary from microscopic size to rhombohedra about three inches in length. It occurs in four distinct forms:

(*a*) Well-formed crystals with sharp boundaries coated with a thin layer of calcite and chlorite.

(*b*) As crystals filling interstices between other early crystals, viz. quartz, laumontite, felspars.

(*c*) As minute crystals encrusting other minerals, particularly in the roughs.

(*d*) Lining joint-planes in the granite.

These occurrences seem to denote three generations: (*a*) being

the earliest formed; (*b*) and (*c*) are of the same age, and are some times found coating (*a*) along cleavage traces; while (*d*), the third generation, occurs as secondary calcite, which may have arisen from the solution and redeposition of the earlier generations.

The calcite often has a considerable percentage of iron present which stains it yellowish-brown to pinkish-brown. In some cases this ferrocalcite appears in spherical form, and of a deep brown colour. In other cases it occurs as minute rhombohedra encrusting laumontite, kaolinized felspar, quartz, and prehnite. Chalybite showing good crystalline form with curved faces also occurs in the centres of vughs. On it there are minute crystals of calcite.

Chlorite occurs in the rock surrounding the vughs as well as in the vughs themselves. Some of it appears to have resulted from the decomposition of the ferromagnesian minerals in the granite, for where these are intact the chlorite is practically absent. Sometimes it appears as pseudomorphs after hornblende, more often as streaks running through other minerals, but never in both forms in the one specimen. It often coats crystalline forms of other minerals; and is also found intergrown with calcite and quartz, giving them a pale green colour.

Epidote has been found only in one quarry where it ranges from microscopic crystals to those about half an inch in length. It has the typical green colour and appears to be associated largely with chlorite. It occurs enclosed in the outer zone of quartz crystals which protrude from the pegmatite. Most of it crystallized out early, but in one specimen, consisting of a network of veins, it occurs growing on the laumontite.

Pyrite is very abundant, and occurs as a constituent of the granite as well as in the vughs and veins. Crystals range in size from microscopic to well-shaped crystals over an inch across. It is very silvery in colour when fresh, but soon tarnishes to a brassy yellow. It is noted that in the cavities the pyrite is in the untarnished condition. Pyrite also occurs in a fresh condition lining joint-planes in the granite. Limonite pseudomorphs occur on the surface and in more weathered parts.

Tourmaline occurs as radiating crystals, sometimes in small groups, sometimes in masses. It is associated with kaolin, quartz, calcite, pyrite, and radiating groups of laumontite. In one locality it is not far from the schorl-rock and tourmaline-albite-rock described by Bryan.

Fluorite.—Only one specimen containing fluorite has been collected. It is purple in colour, and occurs as well-shaped crystals associated with quartz and kaolinized felspar, which it appears to have followed, as it encrusts the pegmatite. On the other hand, it definitely precedes the laumontite.

Molybdenite has previously been recorded as occurring as small flakes at several localities within the granite. It occurs in cavities sometimes associated with quartz and pyrite, sometimes with quartz, chlorite, and calcite. Often small portions are scattered through the granite within a radius of a few inches from a cavity.

Blende has been found only in one quarry, where two specimens were collected by the author. In both cases it is associated with pyrite, while in one quartz, prehnite, calcite, and chlorite are also present. Blowpipe tests indicate that it contains a fairly large percentage of iron. This mineral has not previously been recorded as occurring in the granite, though Ball (loc. cit.) has recorded zinc associated with the silver-lead ore in the phyllites at Indooroopilly.

Kaolin.—One of the most noticeable features in the quarries is the occurrence of patches, often quite large in extent, in which the felspars have been completely kaolinized and the whole rock reduced to a decomposed, crumbly state. It often encloses pyrite, quite fresh and free from limonitic material, and in some places tourmaline and laumontite also occur with it.

Felspar.—The felspars present are so completely kaolinized that it is difficult to determine what they are. In several specimens, however, the vughs are quite empty, and here the felspars are much fresher. They prove to be very like those of the granite itself, that is, acid andesine; but some are richer in soda and should be classed as oligoclase. No albite has been found.

Origin and Relationship of the Minerals.

The mutual relationship of the minerals described above is fairly clear. In the granite itself the order of crystallization is normal. In the pegmatite zone graphic and allied structures are developed, pointing to simultaneous crystallization. Quartz appears to have been in excess of the felspar in the pegmatite zone, and after the felspar had ceased, it continued to produce crystals that are found protruding into the cavities.

Chlorite and epidote occur next, both being found as inclusions in the outer margins of the quartz crystals. Chlorite appeared slightly previous to the epidote, as it is sometimes seen enclosing it, and th junctions between the two are never very sharp. Streaks of chlorit are seen through the felspar crystals. It seems to have been deposite during practically all stages of the sequence. Epidote, on the othe hand, seems to have had a more restricted range. Most of it crysta lized at this time; but in one specimen, consisting of a network o veins of these minerals, it occurs fairly late in the sequence, and found coating laumontite. Pyrite appears at this stage, generall as well-shaped crystals.

It is probable that the next group of minerals to be developed the pneumatolytic group. This includes tourmaline, molybdenit blende, and fluorite. These are not found associated with o another, but have all formed after pyrite and before calcite.

The next mineral in the sequence is calcite. This is certainly n a weathering product, and it is very abundant. Similar calci occurs in other portions of Australia, and W. R. Browne[1] h recorded it from several localities in basic rocks in New South Wale In the present instance it is not known definitely where the lime f the calcite came from. It may have been an original constituent the magma, or it may have arisen from the decomposition of t plagioclase felspars. Calcite appears again in the sequence i mediately following and in part contemporaneous with laumontite

Prehnite follows the calcite. The relationship of this mineral laumontite is an interesting one. In most cases large laumont crystals definitely enclose spherules of prehnite, but some sm crystals of laumontite appear to be surrounded by prehnite. Ho ever, in most cases the prehnite is definitely older than the laumonti

Laumontite sometimes appears to be intergrown with calci alternating plates of each occurring in some specimens. This occ generally near the junction of laumontite and calcite masses, a may be due to the partial replacement of the laumontite by calcite. The laumontite definitely crystallized before the calcite this case.

[1] W. R. Browne, Note on the occurrence of calcite in a basalt from Maitland district, N.S.W. Journ. Roy. Soc. N.S.W., 1923, vol. 56 (for 19 pp. 278–284. Notes on the petrology of the Prospect intrusion, with spe reference to the genesis of the so-called secondary minerals. Ibid., 1925, vol (for 1924), pp. 240–254.

The normal order of crystallization is as follows:

(*a*) Oligoclase (?) ——
(*b*) Quartz ————
(*c*) Epidote ————— —
(*d*) Chlorite ————————————
(*e*) Pyrite ——
(*f*) Pneumatolytic minerals ——
(*g*) Calcite ——— ———
(*h*) Prehnite ———
(*i*) Laumontite ———
(*j*) Gismondite ——
(*k*) Ferrocalcite —

Note: The minerals under (*f*) include tourmaline, molybdenite, blende, and fluorite, not found associated with one another, but all after pyrite and before calcite.

The order shown in the table is characteristic of all specimens, and no departure in any way is made from it. Therefore, it is seen that so far as the silicates are concerned, the order is one of increasing hydration; an order that has also been noted in vesicles by W. F. P. McLintock [1] and by C. N. Fenner.[2]

Oligoclase (?)	...	$m\mathrm{NaAlSi_3O_8}+n\mathrm{CaAl_2Si_2O_8}$.
Epidote ...	...	$4\mathrm{CaO}.3(\mathrm{Al,Fe})_2\mathrm{O_3}.6\mathrm{SiO_2}.\mathrm{H_2O}$.
Prehnite ...	...	$2\mathrm{CaO}.\mathrm{Al_2O_3}.3\mathrm{SiO_2}.\mathrm{H_2O}$.
Laumontite	...	$\mathrm{CaO}.\mathrm{Al_2O_3}.4\mathrm{SiO_2}.4\mathrm{H_2O}$.
Gismondite	...	$\mathrm{CaO}.\mathrm{Al_2O_3}.3\mathrm{SiO_2}.4\mathrm{H_2O}$.

The main features of the vughs may be summed up as follows:

(1) The granite itself is abnormal, and is on the whole lime-rich.

(2) The felspars round the vughs are completely kaolinized and veined with chlorite.

(3) The magma was rich in volatiles, as is shown by the pegmatites and the occurrence of cavities.

(4) Igneous minerals crystallized in these cavities after their formation, as is shown by the marginal pegmatites.

(5) Patches of kaolin associated with fresh pyrite also seem to point to the action of volatiles.

(6) Pneumatolytic minerals are well represented in the sequence.

[1] W. F. P. McLintock, On the zeolites and associated minerals from the Tertiary lavas around Ben More, Mull. Trans. Roy. Soc. Edinburgh, 1915, vol. 51, pp. 1–33.

[2] C. N. Fenner, The Watchung basalt and the paragenesis of its zeolites and other secondary minerals. Ann. N.Y. Acad. Sci., 1910, vol. 20, pp. 93–187.

(7) The minerals have lime for their chief base.

(8) Calcite, generally regarded as a secondary mineral, is presen in large quantities and occurs in a similar manner to the othe minerals.

(9) Typical oxidation products are rare or absent, while th minerals do not occur near the surface, nor are they intimatel associated with joints.

(10) The minerals generally were deposited in an order of in creasing hydration.

Thus the cooling history of the magma is seen to consist of thre principal periods. During the first, the main magmatic consolidatio took place. This was followed by a period of pegmatite formatio and the initiation of cavities in the rock. While the rock was sti hot the deuteric period occurred, beginning with the kaolinizatio of the felspars and chloritization of the ferromagnesian minerals then followed the deposition of chlorite and epidote, the pneumat litic minerals, some calcite, the zeolites, and finally many vughs an veins were completely filled with calcite.

MINERALOGICAL ABSTRACTS

(Vol. 6, No. 10, June, 1937.)

Notices of Books.

[Levinson-Lessing (F. Y.)] Левинсон-Лессинг (Ф. Ю.). Введение в историю петрографии. [An introduction to the history of petrography.] Объед. Научно-Техн. Изд. [United Sci.-Techn. Publ. Co.], Leningrad-Moscow, 1936, pp. 138. Price 5 rubles.

This book is the result of experience gained during more than fifty years' intensive work in the field of petrography and petrology. The author is well known to all petrologists, and his mature views are, without any doubt, of great value. The subject is treated from various viewpoints—geological, structural, chemical, experimental, and synthetic—to each of which is devoted a chapter. Within each chapter the matter is further subdivided and discussed chronologically. The book is not merely an historical account, but a critical discussion of the leading ideas evolved and the crucial facts discovered during the last half-century. The bibliography of over 250 items includes a number of Russian works. A translation of this book would be welcome. S. I. T.

Skitin (W.). *Die Fedorow-Methode.* Berlin (Borntraeger), 1936, iv + 109 pp., 7 pls., 41 text-figs. Price RM. 12.40.

This description of the methods of studying the optical orientation of felspars and of other non-opaque minerals by means of the Fedorov universal microscope stage is a very welcome contribution to the literature. It gives a brief history of the growth of the subject in the form of titles and short abstracts of the more important publications. Then follows a description of the apparatus now available and of the principles and details of the methods for determining the optic axes and principal planes of uniaxial and biaxial minerals. This section contains many useful details of technique and discussions of the accuracy of the method and means of improving it. Particular attention is given to the correction for differences between the refractive indices of the glass segments and minerals, and a diagram for the application of corrections is given. Of special importance is a discussion of the influence of these refractive index differences on the correct orientation of uniaxial minerals. For minerals of low

birefringence thicker sections than those usually prepared can be use with advantage, and, on such, observations in convergent light ca be made. A method of determining refractive index is described i chapter 3, and birefringence in chapter 4. Chapter 5 contains som account of indirect methods for estimating birefringence and 2V an the relation between optic axial angle and extinction-angles. Chapter deals with the determination of the position of crystal faces, cleavage and twin-planes, and, finally, chapter 7 briefly describes the speci application of the method to the felspars and embodies all the late results obtained by the author for the correction and completion the projections used for the interpretation of the universal sta measurements on plagioclase felspars. [M.A. **5**–364.] W. C. S.

Hatch (F. H.) [1864–1932] & Wells (A. K.). *The petrology of t igneous rocks.* 9th edition, London (George Allen & Unwi 1937, xx + 368 pp., 154 figs. Price 15*s*.

The half-title of this successful and useful text-book reads: 'Tex book of petrology, vol. 1.' This volume covers the same ground the first edition of 1891 (128 pp.), the fifth edition of 1909 (420 pp and the eighth edition of 1926 with A. K. Wells (590 pp.) [M.A. 61]. Vol. 2 on the sedimentary rocks and their metamorphic deriv tives first appeared in 1913 [M.A. **2**–3]. The considerable reducti in the number of pages of this edition is explained by the closer- type and the larger-sized page; and the account of the metamorp igneous rocks, which was included in the eighth edition, is now reserv for a future edition of vol. 2. Petrology has evidently not yet settl down. 'No one scheme of classification can fulfil all the purposes petrology, and certainly no one scheme will ever satisfy all pet logists' (p. 138). A new scheme, different from those in both fifth and eighth editions, is now tried out. Rocks are grouped in 'clans' (suggesting a Scotch edition)—granite clan, gabbro clan, &c and each of these is subdivided according to grain-size. Those of coa grain-size are plutonites; those of medium grain-size include mic granites, &c.; and those of fine grain-size correspond to the lav Another sign of instability is the change in the spelling of felspar the German form feldspar. A future edition may perhaps arrive the original Swedish form feldtspar. Chapter III gives a useful o line of past igneous activity in the British Isles. The text is v written and printed, with good illustrations, but there are sev minor errors and misprints. L. J. S.

ONGEREN (W. van). *Gravimetric analysis, a laboratory manual with special reference to the analysis of natural minerals and rocks.* Amsterdam (D. B. Centen's Uitgevers-Maatschappij), 1937. xi+278 pp., 16 figs. [London agents, H. K. Lewis & Co.] Price 14*s*.

This useful little book is written in excellent English, and gives a ood, up-to-date account of its subject. Volumetric methods are xcluded. The analysis of rocks, silicate, sulphide, carbonate, ulphate, phosphate, borate, halide, and nitrate minerals, natural aters, alloys, cements, slags, glasses, coal, and plant ash, is dealt ith. In a book of this size the treatment is necessarily condensed, t most of the best methods are mentioned, and sufficient leading ferences are given to enable appropriate processes to be selected d worked for any case. The treatment is excellent on the whole, d while the reviewer cannot agree that the asbestos-filled Gooch ucible is obsolete, or with the small number of elements considered fficient for a complete rock analysis, this is largely a matter of rsonal preference. M. H. H.

ENDL (Miklós). *Kőzet-, szén- és ércmeghatározó módszerek.* [Methods for the determination of rocks, coals, and ores.] Sopron (Dept. of Mining, Metallurgy, and Forestry of the Royal Hungarian Palatine-Joseph University), 1935, 367 pp., 210 figs. Price 16 pengős.

In this excellent work, which is intended for use as a text-book d practical guide, the author gives the results of his many years' perience. The optical, chemical, and palaeontological methods in mmon use for the examination of rocks, coals, and ores, and also e mechanical analysis of sediments, are clearly and concisely stated. e theory underlying the practical methods is also explained.

V. Z.

WE (Fritz). *Atlas der Analysen-Linien der wichtigsten Elemente.* 2nd edit., Dresden & Leipzig (Theodor Steinkopff), 1936, 37 pp., 16 pls., 3 text-figs. Price RM. 10 (bound).

This is the second and somewhat cheaper edition of the author's tlas der letzten Linien der wichtigsten Elemente' [M.A. **4**–6], ich is a useful book of reference giving photographs and tables of spark spectra of all the more important elements. F. A. B.

New Minerals.

Zsivny (Viktor). *Az 1934 és 1935 években leírt új ásványfajok ásványvarietások.* [New mineral species and mineral variet described in the years 1934 and 1935.] Magyar Chem Folyóirat, 1936, vol. 42, pp. 190–196.

The chemical composition, locality, and reference to the literatu are given for each new mineral described in 1934–1935. Supplemen are added to the previous lists for 1930–1931 and 1932–1933 [M. **5**–149, 486]. V. Z.

[Sokolov (G. A.)] Соколов (Г. А.). Корундовые плагиоклази Каслинской дачи на Урале.—Sokolov (G.). *The corund plagioclasites of Kaslinskaia Dacha in the Urals.* Труд. Гла Геол. Разв. Упр. СССР (Trans. Geol. Prosp. Service USS 1931, no. 56, pp. 3–46, 2 pl., 13 text-figs. (Russian w English summary.)

Under the name of 'corundum plagioclasite' the author assemb rocks previously named kyshtymite, barsovite, plumasite, corundum-anorthosite [M.A. **1**–210, **2**–80, **3**–84]. The corundu plagioclasites of the Urals are composed of plagioclase (albite anorthite), a variable amount of corundum, muscovite, biot rutile, zircon, spinel, magnetite, and apatite. Marundite is a pn matolitically altered corundum-plagioclasite containing marga and tourmaline. In the Kaslinskaya Dacha, veins and irregu masses of corundum-plagioclasite and plagioclasite are intrusive i serpentine and peridotite. The exocontact zones are as follo (1) vermiculite, (2) enstatite-actinolite-chlorite, (3) serpentine, o altered with the development of sungulite, chlorite, quartz, chalcedo carbonates, and brown iron oxides. *Sungulite* (сунгулит) is a var of serpentine [M.A. **6**–219]. It is greenish-white, in the form of ver cular prisms (often twisted), with a perfect basal cleavage, wea pleochroic, uniaxial, negative, average n 1·545, $\gamma - \alpha$ 0·016. material analysed (anal. I; also CO_2 1·35) from lake Sungul cont hornblende 3·0, calcite 1·5, and apatite 0·4 %. The heating cu shows terraces at 710°, 410°, and 260° C. The other analysed mine from Sungul are: vermiculite (anal. II), weakly pleochroic, 2V small, $\gamma - \alpha$ 0·051; and white chlorite (anal. III) from the sec zone, 2V very small, $\gamma - \alpha$ 0·009 (probably pennine). Corund plagioclasites and plagioclasites are probably genetically conne

with granitic magma and its hybrids (migmatites, amphibole-plagioclase-gneiss), and have probably originated through desilicification of the highly fluid magma which was followed by the silicification of the contact basic rocks [cf. M.A. **4**–47, 129]. Sungulitization, carbonatization, &c., are considered to be the last stages of this process.

	SiO_2.	TiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2O.	H_2O+.	H_2O-.
I.	42·25	trace	3·04	1·77	nil	trace	36·37	1·13	0·54	0·38	11·32	2·65
II.	31·55	0·61	15·90	1·42	5·68	0·03	21·68	0·28	0·25	0·20	11·25	11·36
III.	34·77	0·71	21·90	3·77	0·80	0·02	17·97	0·04	0·19	0·08	10·92	9·04

S. I. T.

Grigoriev (P. K.)] Григорьев (П. К.). Материалы по пегматитам Сев. Карелии.—Grigoriev (P. K.). *Pegmatites of north Karelia.* Труд. Центр. Научно-Иссл. Геол.-Разв. Инст. (Trans. Central Geol. Prosp. Inst. USSR), 1935, no. 37, 108 pp., 1 map, 24 text-figs. (Russian with English summary.)

The pre-Cambrian rocks of the district of northern Karelia adjoining the White Sea comprise (in order of relative age): gneisses, gabbro-norites (drusites), granites with migmatites, pegmatite and aplite veins. The pegmatites are composed of quartz, microcline-microperthite, plagioclase, biotite, muscovite, while some also contain tourmaline, garnet, and apatite. A number of accessory minerals are also recorded, including cyrtolite, uraninite, gummite, xenotime, monazite, and a new mineral, *carburan* (карбуран), which, according to A. N. Labuntzov, contains about C 60, H_2O+ 19·3, H_2O- 9·7, Ash 9·5 (UO_3 54·20, PbO 17, Fe_2O_3 6) and is apparently analogous to uraconcholite [M.A. **4**–11]. A number of analyses of rocks and minerals are given and a classification of pegmatites suggested. S. I. T.

Shabynin (L. I.)] Шабынин (Л. И.). О марганцовом цоизите Борзовского месторождения корунда на Урале.—Shabynin (L.). *On the manganese zoisite of the Borzovka* [*corundum*] *deposits on the Ural.* Зап. Всеросс. Мин. Общ. (Mém. Soc. Russe Min.), 1934, ser. 2, vol. 63, pp. 456–460, 1 pl. (Russian with English summary.)

Manganese-zoisite is found filling fissures in a vein of corundum-hornblende-plagioclasite. It is bright pink, in radial aggregates, sp. gr. 3·22, H. 6–6½, nonpleochroic, straight extinction, positive elongation, optic axial plane perpendicular to (010), α 1·693, γ 1·697, strong dispersion, $r > v$, 2V 52° (white), 48° (yellow), 56° (red). Analysis by V. K. Purtova gave SiO_2 37·86, Al_2O_3 31·78, Fe_2O_3 0·90,

B_2O_3 nil, MnO 0·47, MgO 0·11, CaO 25·36, H_2O 3·80 = 100·28. Th paragenetic association of Mn-zoisite is as follows: rutile, pyrite tourmaline, clinochlore, prehnite, calcite, Mn-zoisite (partly replacin earlier minerals). S. I. T.

[Krutov (G. A.)] Крутов (Г. А.). Дашкесанит—новый хлорсоде жащий амфибол группы гастингсита.—Krutov (G. A.). *Dash kessanite—a new chlorine amphibole of the hastingsite grou* Изв. Акад. Наук СССР, Отд. Мат. Ест., Сер. Геол. (Bull. Aca Sci. URSS, Cl. Sci. Mat. Nat., Sér. Géol.), 1936, pp. 341–37 8 figs. (Russian), pp. 371–373 (English summary).

Surrounding sheets of magnetite in gabbro-porphyrite at Das kesan, Transcaucasia, is a zone (60–75 cm. thick) of skarn consistir almost wholly of amphibole. This is greenish-black and granul with pleochroism, α pale orange-yellow, β dark bluish-green, γ da greenish-blue; α' 1·728, γ' 1·751, 2V 15° ± 5°, negative, axial pla (010), $\gamma : c = 11°$, cleavage angle 55°, H. 4½–5, sp. gr. 3·59. Therm curves and X-ray patterns agree with those of amphibole, but the u cell is slightly larger. The mineral fuses to a black glass and is c composed by HCl. Analysis by R. E. Yakubovich gave SiO_2 36·1 TiO_2 0·30, Al_2O_3 10·22, Fe_2O_3 7·60, FeO 19·99, MnO 0·43, MgO 3·6 CaO 10·83, Na_2O 1·24, K_2O 2·84, Li_2O 0·02, Cl 7·24, F nil, H (+110°) 1·05, H_2O (−110°) 0·22, P_2O_5 0·10, SO_3 0·11 = 101· (less O for Cl 100·32). Another analysis shows Cl 5·59. Form $R'_4R''_5R'''_2(SiO_3)_8(OH,Cl)_4$; where R′ = Na, K, H, Ca; R″ = F Mn, Mg; and R‴ = Al, Fe‴. The associated igneous rocks cont small amounts (up to 0·13%) of chlorine, and the *dashkesanite* is pneumatolytic origin. L. J. S

[Nikitin (V. D.)] Никитин (В. Д.). Новая разновидность минер оливиновой группы.—Nikitin (W. D.). *A new variety of olivine group.* Зап. Всеросс. Мин. Общ. (Mém. Soc. Russe Mi 1936, ser. 2, vol. 65, pp. 281–288, 3 figs. (Russian with Engl summary.)

Brown, rough, orthorhombic crystals (4–5 cm.) occur in pegmat cutting granite in the Talassa valley, Kirghiz republic, Siberia. Tl have cleavages (001) very perfect, (010) perfect, and (001) good. O axial plane (001), $Bx_\alpha \perp (010)$, 2V 49°, α 1·870, γ 1·908; pleochro very slight; sp. gr. 4·1. Analysis gave SiO_2 29·87, TiO_2 0·08, Fe

12·07, FeO 54·88, MnO 0·02, MgO 2·54, CaO 0·20, Na_2O 0·71, K_2O 0·08 = 100·45; formula $20FeO.2MgO.2Fe_2O_3.13SiO_2$, or approximately $(Fe'',Mg)_5Fe'''(SiO_4)_3$. These characters distinguish the mineral from fayalite, and it is named *talasskite*. L. J. S.

[Efremov (N. E.)] Ефремов (Н. Е.). Лабит—новый минерал.—Efremov (N. E.). *Labite—a new mineral*. Зап. Всеросс. Мин. Общ. (Mém. Soc. Russe Min.), 1936, ser. 2, vol. 65, pp. 108–117, 2 figs. (Russian with English summary.)

This mineral is from the Beden serpentine massif on the Great Laba river, northern Caucasus. It forms yellowish-green aggregates of interlacing fibres, like pilolite. The fibres have straight extinction with positive elongation; biaxial negative with the optic axial plane parallel to the fibre; n about 1·52, birefringence 0·004–0·006. The optical characters suggest orthorhombic symmetry. Sp. gr. about 2·25. Analyses, SiO_2 66·23 (67·43), Al_2O_3 2·24 (1·83), Fe_2O_3 0·69 (0·50), MgO 14·66 (15·61), CaO 1·15 (0·55), H_2O+ 7·04 (7·10), H_2O- 7·39 (7·33), total 100·40 (100·35), give a formula $H_2MgSi_3O_8.H_2O$. This approaches the hypothetical picrocollite $(H_4MgSi_3O_9.2H_2O)$ suggested by E. S. Simpson [M.A. **3**–545] as an end-member of the pilolite-palygorskite group. L. J. S.

[Efremov (N. E.)] Ефремов (Н. Е.). Кальциевый ферри-фосфат—новый минерал из класса фосфатов.—Efremov (N. E.). *Calcium ferri-phosphate, a new mineral of the phosp[h]ate class*. Зап. Всеросс. Мин. Общ. (Mém. Soc. Russe Min.), 1936, ser. 2, vol. 65, pp. 225–232, 1 fig. (Russian with English summary.)

The following minerals have not been previously recorded from the iron-ore deposits of the Taman and Kerch peninsulas in south Russia: montronite, halloysite, ferri-halloysite, montmorillonite, chamoisite, limonite, rhodochrosite, siderodote, pyrolusite, jarosite, goethite, hydrogoethite, turgite, and a new calcium ferri-phosphate. The last occurs in an ore bed with fossil shells (Pliocene) at Tamanskaya. It is light brown, gel-like, brittle, H. 2–3, optically isotropic, n 1·605–1·610 (sometimes 1·675), and soluble in acids. Analysis gave P_2O_5 32·70, Al_2O_3 2·65, Fe_2O_3 28·96, FeO 0·53, MnO 0·12, MgO 0·62, CaO 8·20, H_2O+ 13·46, H_2O- 20·89, SiO_2 1·42 = 99·55; formula $3CaO.3Fe_2O_3.2P_2O_5.10H_2O$ + 16 aq. It is compared with calcioferrite, barrickite, foucherite, and anapaite. L. J. S.

Scholtz (Douglas L.). *The magmatic nickeliferous ore deposits of East Griqualand and Pondoland. (Part I.)* Trans. Geol. Soc. South Africa, 1937, vol. 39 (for 1936), pp. 81–210, 16 + 2 pls., 15 text-figs. Preprints as Publ. Univ. Pretoria, Ser. 2, 1936, no. 1. Price 7*s.* 6*d.*

The large basin-shaped sheet, 1000–3000 feet thick, intrusive into Karroo beds in the Insizwa range shows: a roof zone of granitic rocks; a central zone of gabbros; and a basal zone of hyperites, picrites, and troctolite, with sulphides and veins of acid rocks. Petrographical descriptions with chemical analyses are given of the rocks of the basal zone, and the microscopical characters of the ores are described in detail. The ores are of two types: (*a*) pyrrhotine (*α* and *β*), chalcopyrite, and pentlandite; (*b*) chalcopyrite, pentlandite, cubanite, and bornite. Analysis of pyrrhotine gave S 38·1, Fe 60·4, Cu 1·1, Ni 0·3, corresponding with $Fe_{21}S_{23}$; of chalcopyrite S 36·5, Fe 32·4, Cu 31·5, Ni 0·0; and of cubanite S 38·0, Fe 40·7, Cu 20·8, Ni 0·0, corresponding with $Cu_2Fe_5S_8$. Other minerals in the ores are magnetite, ilmenite, sperrylite, pyrite, bravoite, valleriite, blende, niccolite, millerite, chalcosine, covelline, and sixteen undetermined minerals A–Q. Two of the last are given new names. *Niggliite*, a silver-white grains with strong anisotropism and pleochroism, containing platinum (34·8 %) and tellurium, suggesting a formula PtTe$_2$. *Parkerite* marks paper and resembles molybdenite in appearance, but cleaves in three directions, giving rhomboidal plates. It is strongly anisotropic and shows twin-lamellae, and the Laue pattern indicates monoclinic symmetry. Analysis made on a few milligrams suggests a formula Ni_2S_3 (or NiS_2). L. J. S.

Mário de Jesus (Amílcar). *Pegmatites mangano-litiníferas da região de Mangualde.* Comunicações Serv. Geol. Portugal, 193[illegible] [i.e. 1936], vol. 19, pp. 65–210, 1 map, 17 pls., 1 text-fig. [Vol. 19, as a single part, is dated 1933 on the title-page. This paper bears the date December 1934. Copies received in libraries in 1936.]

Petrographical descriptions and chemical analyses are given of granites of various types and of pegmatite around Mangualde, prov. Beira. Several phases in the formation of the pegmatite are distinguished: magmatic, with large masses of orthoclase (anal. I) and quartz, some albite (II) and muscovite, and several types of perthite; hydrothermal at high temperature, with tourmaline, quartz,

muscovite, cassiterite, and albitization of the orthoclase; hydrothermal phosphatic phase, with heterophyllite, mangualdite, brandãosite, lithiophilite, triplite, beryl, tourmaline, muscovite, orthoclase, quartz, and albite; hydrothermal sulphide phase, with molybdenite,

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2O.	P_2O_5.	H_2O +.	H_2O −.
I.	64·55	18·61	0·51	0·15	0·01	0·04	0·13	1·02	14·46	0·28	0·43	0·05
II.	67·78	19·59	0·26	0·22	—	0·05	0·43	9·74	1·92	—	0·57	0·25
III.	35·48	21·73	2·14	19·60	1·13	0·34	0·06	2·42	9·28	0·18	4·72	1·72
IV.	35·91	12·18	5·52	23·66	18·88	1·48	0·50	0·66	0·31	0·25	0·44	0·13
V.	40·29	7·32	26·26	—	—	0·01	1·56	0·50	0·22	0·20	7·79	16·49
VI.	52·91	18·50	2·27	—	0·12	3·11	0·94	0·24	0·46	0·01	8·59	13·03

III, also TiO_2 0·70, F 0·86. IV, also TiO_2 0·21.

	P_2O_5.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2O.	SiO_2.	F.	H_2O +.	H_2O −.
VII.	44·14	21·82	22·36	0·36	1·80	1·33	—	0·26	—	—	—
VIII.	42·61	2·97	31·47	1·48	17·75	0·74	0·11	2·04	1·05	0·31	0·22
IX.	32·15	20·34	36·52	0·91	2·86	0·38	0·27	0·24	7·35	0·13	0·07
X.	26·67	—	29·90	0·17	2·18	0·82	1·18	0·20	5·02	4·70	2·50
XI.	38·72	—	—	0·04	1·28	1·07	—	0·27	—	3·74	2·33
XII.	36·27	13·50	34·82	0·35	1·73	0·43	—	0·06	—	11·96	0·55
XIII.	37·60	—	—	0·10	0·83	0·55	—	0·10	—	17·94	1·17
XIV.	26·59	1·81	0·57	20·69	31·52	0·37	0·25	4·13	7·75	—	0·16

VII, also Li_2O 8·04. VIII, also Cl 0·26. IX, also Fe_2O_3 2·50. X, also Fe_2O_3 24·20, Mn_2O_3 4·74. XI, also Fe_2O_3 28·20, Mn_2O_3 24·45, Li_2O 0·11. XIII, also Fe_2O_3 41·42, Mn_2O_3 0·51.

blende, chalcopyrite, pyrite, arsenopyrite, and quartz; mixed hydrothermal and supergene phase, with metatriplite, neopurpurite, pseudolaite, strengite, müllerite, mesquitelite, and oxides and hydrated phosphates of Mn and Fe. *Heterophyllite* is a variety of biotite, sp. gr. 3·06, uniaxial, negative; anal. III gives a formula

$$H_8K_4Fe_4Al_6Si_8O_{35},$$

intermediate between those of siderophyllite and annite. *Brandãosite* in red icositetrahedra, sp. gr. 4·23, is an almandine-spessartine, but anal. IV gives a formula, $4(Fe,Mn)O.(Al,Fe)_2O_3.4SiO_2$, departing from that of garnet. Müllerite (= zamboninite) as green earthy material, sp. gr. 2·29, in rock crevices; anal. V, $(Fe,Al)_2O_3.3SiO_2.2H_2O$. *Mesitelite*, sp. gr. 2·12, a clayey alteration product of felspar; anal. VI gives a formula, $(Mg,Ca)O.2Al_2O_3.9SiO_2.5H_2O$, near to that of montmorillonite. Lithiophilite, the most abundant of the phosphate minerals, gave anal. VII, sp. gr. 3·52. *Mangualdite*, as rough olive-green crystals, probably orthorhombic, sp. gr. 3·33; anal. VIII gives

$3RO.P_2O_5$. Triplite, sp. gr. 3·79; anal. IX, $3RO.P_2O_5.RF_2$. *Meta-triplite*, sp. gr. 3·55, a black alteration product of triplite; anal. X $6RO.3R_2O_3.3P_2O_5.2RF_2.4H_2O$. *Neopurpurite*, sp. gr. 3·23, an alteration product of lithiophilite, showing a violet colour on (001) cleavages and black on (010) cleavages, and with intense pleochroism; anal. XI, $7R_2O_3.5P_2O_5.4H_2O$. *Pseudopalaite*, sp. gr. 3·05, an alteration product of lithiophilite, as a flesh-red crust of minute monoclinic crystals; anal. XII gives a formula, $6RO.2P_2O_5.5H_2O$, differing slightly from that of palaite. Strengite, as violet-blue crusts on other phosphates; anal. XIII, $Fe_2O_3.P_2O_5.4H_2O$. A fluophosphate of calcium and magnesium, as white earthy crusts on metatriplite, gave anal. XIV and is doubtfully compared with cryphiolite. L. J. S.

Wang (C. C.). *The rhodonite veins of Hsihutsun, Changping district, north of Peiping.* Bull. Geol. Soc. China, 1936, vol. 15, pp. 87–104, 4 pls., 6 text-figs.

Veins 0·3–2 m. wide of rhodonite and quartz occur in the contact zone between siliceous limestone and plagiaplite. The pink rhodonite is colourless in thin sections and shows (110) and ($1\bar{1}0$) cleavage with oblique extinctions; α 1·7174, β 1·728, γ 1·7313, 2V 80°, positive but sometimes negative. Analysis by S. C. Liang gave Si 44·30, Al_2O_3 0·78, Fe_2O_3 1·79, MnO 42·18, MgO 6·24, CaO 4·3 moisture 0·10, ign. loss 0·21 = 99·91. Another analysis shows Zn 4%. This composition differs from that of fowlerite and ordinary rhodonite, and the name *hsihutsunite* is suggested. Secondary minerals are psilomelane, manganite (MnO_2 75·47, Fe 0·90, SiO_2 0·39, Zn 0·1, moisture 3·79, ign. loss 15·88), pyrolusite, wad, and calcite.

L. J. S.

Hurlbut (Cornelius S. *Jr.*). *A new phosphate, bermanite, occurring with triplite in Arizona.* Amer. Min., 1936, vol. 21, pp. 651–661, 2 figs.

Large globular masses consisting mainly of triplite, with cleavage up to six inches across, are found in pegmatite knots at several places about 25 miles west of Hillside. Analyses by F. A. Gonyer of triplite from: I, '7U7 Ranch' (α 1·651, β 1·653, γ 1·665, $a = b$, $\gamma : a = 22°$. II, Mt. Loma (α 1·662, β 1·673, γ 1·684, $\beta = b$, $\gamma : a = 42°$). Bermanite occurs as small reddish-brown tabular crystals in veinlets in the triplite. It is orthorhombic with perfect (001) cleavage, $a : b : c = 0·6890 : 1 : 2·2018$; sp. gr. 2·84, H. $3\frac{1}{2}$, α 1·687, β 1·71, γ 1·748, α light red = c, β pale yellow, γ deep red = a; analysis

gives the formula $R''_5R'''_8(PO_4)_8(OH)_{10}.15H_2O$. The unit cell, a 6·25, b 8·92, c 19·61 Å., contains one such molecule. Associated with bermanite are torbernite and minute crystals of five unidentified phosphates for which optical data are given.

	P_2O_5.	Fe_2O_3.	FeO.	Mn_2O_3.	MnO.	MgO.	CaO.	Na_2O.	H_2O.	F.
I.	33·32	—	11·68	—	34·55	11·87	2·48	0·52	0·75	8·02
II.	32·20	0·40	6·68	—	53·77	0·31	2·17	—	—	7·58
III.	31·39	3·03	—	28·76	13·79	2·39	0·72	0·32	19·33	—

L. J. S.

Peacock (M. A.) & Bandy (M. C.). *Ungemachite and clino-ungemachite—new minerals from Chile.* Amer. Min., 1936, vol. 21, no. 12, pt. 2, p. [2]; 1937, vol. 22, p. 207. [Abstract.]

Ungemachite occurs as colourless rhombohedral crystals with ideronatrite in altered iron sulphates at Chuquicamata, Chile. $: c = 1 : 2·2966$, $\alpha = 62° 51\frac{1}{2}'$, cleavage (111) perfect, H. $2\frac{1}{2}$, sp. gr. ·287, ω 1·502, ϵ 1·449. Analysis by F. A. Gonyer, SO_3 40·23, Fe_2O_3 7·69, Na_2O 21·61, K_2O 11·35, H_2O 16·69, N_2O_5 trace, insol. ·07 = 99·64. The unit cell, a 10·84, c 24·82 Å., contains

$$Na_8(K,Fe''')_4(OH)_2(SO_3)_6.10H_2O.$$

ino-ungemachite is monoclinic (pseudo-rhombohedral) with $: b : c = 1·6327 : 1 : 1·7308$, $\beta = 69° 20'$, and properties close to hose of ungemachite. L. J. S.

ester (G. A.) & Cruellas (J.). *Broggita (nueva especie mineral).* Bol. Soc. Geol. Peru, Lima, 1935, vol. 7, pp. 14–15.

A bituminous material occurring with Cretaceous coal at Goyllarisizga, Peru, resembles asphaltum in appearance but is rather rowner in colour and contains no vanadium. Analysis gave moisture 64, volatile matter 31·8, fixed carbon 17·2, ash (Si,Al,Ca,Mn,Ni) ·0 %. In alcohol 2·42 % is dissolved and in benzene 11·39 %.

L. J. S.

ennedy (W. Q.) & Dixon (B. E.). *Hydro-amphibole from South Devon.* Zeits. Krist., 1936, vol. 94, pp. 280–287.

Colourless acicular amphibole, resembling tremolite, forms the lk of an amphibole-talc-chlorite-schist, which occurs as narrow nds and lenses in the chlorite-epidote-schists near Salcombe. It s sp. gr. 2·95, α 1·615, γ 1·637, 2V 77°, negative, $\gamma : c = 17°$; alysis, SiO_2 44·56, TiO_2 0·56, Al_2O_3 9·57, Cr_2O_3 0·14, Fe_2O_3 0·54, O 7·99, NiO 0·13, MnO 0·22, MgO 22·37, CaO 7·94, Na_2O 0·27,

K_2O 0·07, H_2O (< 105°) 0·27, H_2O (400–500°) 1·25, H_2O (> 750°) 4·26, P_2O_5 and FeS_2 traces, F nil = 100·14, gives $H_4R''_7(Si,Al)_8O_{24}$, or double the amount of water required by Warren's amphibole formula [M.A. **4**–201]. When the mineral is heated it behaves quite differently to tremolite; at 400–500° there is no change in the optical characters, but at about 1000° it is converted into a highly pleochroic basaltic hornblende, α 1·635, γ 1·662, 2V 58°, negative, $\gamma : c = 5°$; analysis, SiO_2 46·80, Fe_2O_3 9·70, FeO 0·17, H_2O trace, &c. L. J. S.

Carobbi (Guido). *Fluoruro di alluminio, magnesio e calcio, bisolfato sodico, mercallite ed hieratite fra i prodotti dell' attività fumarolica vesuviana del 1934.* Atti (Mem.) Accad. Sci. Lett. Arti, Modena 1936, ser. 5, vol. 1, pp. 33–42.

Stalactites were collected in February 1934 from a cavern in the lava of December 1933 on the floor of the crater of Vesuvius. Analyses of the interior (and exterior) portions gave Si 0·58 (0·38), Cl 2·45 (5·11), F 28·73 (7·95), SO_4 14·87 (52·83), OH 12·41 (—), H 0·20 (0·69), Al 15·05 (0·37), Fe 0·16 (0·24), Cu nil (0·69), Mg 4·83 (—), Ca 4·45 (0·19), Na 6·10 (13·71), K 5·23 (13·48), NH_4 nil (0·30), H_2O 4·50 (3·84), total 99·53 (99·78). The material of the interior is mostly amorphous with n 1·406 (1·40–1·41) and a formula $(Ca,Na_2)F_2.MgF_2.2Al(F,OH)$ is deduced, but in the absence of crystallographic data no name is given to this new species. The material of the exterior is a greyish-white powder in which under the microscope the following were identified: minute crystals of mercallite, $KHSO_4$ [M.A. **6**–148]; cubic crystals of hieratite, K_2SiF_6, n 1·339; and cubes of potassium fluoride, n 1·362. The presence of $NaHSO_4$ as a new mineral is also suggested by the analysis. L. J. S.

Instruments and Apparatus.

[Zavaritzky (A. N.)] Заварицкий (А. Н.). Интерференционный микро-рефрактометр и его применение в минералогии и петрографии. —Zavaritsky (A. N.). *The interference microrefractometer and its application to mineralogy and petrography.* Всесоюзный научно-иссл. инст. минер. сырья. (All-Union Sci. Research Inst. Econ. Miner.), Moscow, 1936, 46 pp., 19 text-figs. (Russia with English summary.)

This paper describes a method of measuring the index of refraction of minerals in thin sections. Two quartz plates cut at an angle of 45° to the optic axis and one half-undulation mica-plate are used in

ne construction of the apparatus. This method can also be combined ith the immersion method. S. I. T.

AWLINS (F. I. G.) & HAWKSLEY (C. W.). *A cell for refractivity measurements on minute crystals.* Journ. Sci. Instr. London, 1934, vol. 11, pp. 282–284, 2 figs.

A glass cell is described in which a small crystal, mounted on a lder, may be immersed in liquid and observed under the micro- ope. Provision is made for rotation about a horizontal axis. The e of the apparatus for refractive index measurements is described. M. H. H.

ENCE (D. S.). *A method of finding the refractive index of a drop of mounting medium.* Journ. Roy. Microsc. Soc., 1929, ser. 3, vol. 49, pp. 224–227, 1 fig.

A simplified form of the method of E. M. Nelson (1894) for the termination of the refractive index of a liquid by means of the croscope is described. The method requires but little auxiliary paratus, and, unlike methods based on total reflection, there is no per limit to the refractive indices determinable. M. H. H.

ND (A. H.). *A plane-parallel plate refractometer.* Journ. Opt. Soc. Amer., 1931, vol. 21, pp. 182–186, 5 figs.

A simple form of total reflectometer, suitable for use with liquids, described. The instrument may readily be made from inexpensive terials and gives results accurate to 0·001. M. H. H.

ER (Wilhelm). *Über ein Polarisationsreflektometer und über den Brewsterschen Winkel bei optisch einachsigen Kristallen.* Zeits. Instrumentenkunde, Berlin, 1935, vol. 55, pp. 49–63, 7 figs.

An instrument for measuring the polarizing angle of reflection $i = n$) gives approximate values of n, and is especially useful the determination of gemstones with $n > 1{\cdot}8$. The anomalous ult given by calcite is examined. L. J. S.

ENO (T.). *Microscope with universally movable tube.* Amer. Min., 1936, vol. 21, pp. 295–298, 2 figs.

The instrument is designed for determining the refractive indices the dispersion method of crystal grains (since these are liable to vement in the liquid when on the Fedorov stage); it can also be d for measuring optic axial angles, &c. The microscope tube and

illuminator are carried on a circle 29 cm. in diameter which ca rotate in its own plane and also about a horizontal axis. L. J. S.

Wood (R. G.) & Ayliffe (S. H.). *An instrument for measuring t optical constants of small crystals.* Journ. Sci. Instr. Londo 1935, vol. 12, pp. 194–196, 1 fig.

—— —— *A method for determining the orientation of a crystal und a microscope.* Ibid., p. 299, 1 fig.

—— —— *A method for determining the optical constants of cryst and examples of its application to certain organic compoun* Phil. Mag., 1936, ser. 7, vol. 21, pp. 321–336, 8 figs.

A simple form of stage-goniometer is described, enabling a cryst to be rotated about a horizontal axis while immersed in a liqui Very little liquid is used. A method for adjusting a face of t crystal normal to the microscope axis, by means of an auxilia telescope and collimator, is described. By means of this apparat the refractive indices of a crystal may readily be determined by t immersion method, or a crystal with known refractive indices (a preferably high birefringence) may be used to determine the refracti index of a liquid. Goniometric and optical data are given for picry aniline, picryl *p*-toluidine (yellow and red forms), diphenyl eth diphenyl sulphone. M. H. H.

Rose (H.) & Ehringhaus (A.). *Thermostaten für thermisch-optis Untersuchungen mit dem Reflexionsgoniometer.* Fortsch. M Krist. Petr., 1934, vol. 18, pp. 69–110, 16 figs.

A review is given of the various forms of heating apparatus th have been used in combination with the goniometer for measuri crystal angles and refractive indices at various temperatures, anc new instrument with a range from $-125°$ to $+1400°$ C. is describ L. J. S.

Hasler (M. F.) & Lindhurst (R. W.). *A rotating sector for qua tative analytical spectrography.* Rev. Sci. Instruments (Am Inst. Physics), 1936, vol. 7, pp. 137–139, 2 figs.

By using a half-cylinder shutter rotating about its axis, which parallel to the plane of the photographic plate or film, the spect lines fade out at the centre. The ratio of the intensities of t lines is then inversely proportional to the ratio of lengths of gaps the centres of the two lines. This method has several advanta compared with the rotating logarithmic sector method. F. A. B.

SYROMYATNIKOV (F. V.). *The micropycnometric method for the determination of specific gravities of minerals.* Amer. Min., 1935, vol. 20, pp. 364–370, 1 fig.

The various methods for the determination of the specific gravity of small amounts of material are reviewed. The form of micropyknometer described is a bulb-tube of 0·07 c.c. capacity and covered with a glass plate. Using about 0·04 gram of material, the error is $\pm 0{\cdot}01$. L. J. S.

KERR (Paul F.). *An improved specific gravity balance.* Amer. Min., 1936, vol. 21, pp. 121–124, 2 figs.

This balance, suitable for determining the specific gravity of gemstones, is provided with a graduated beam and riders (no loose weights being used). The two pans, one in air and one in water, are on the right; and the weight in air is given by riders on the left-hand side of the beam, and the loss of weight in water by riders on the right-hand side. L. J. S.

BERNAL (J. D.) & CROWFOOT (D.). *Use of the centrifuge in determining the density of small crystals.* Nature, London, 1934, vol. 134, pp. 809–810; 1935, vol. 135, p. 305.

By the use of a centrifuge to accelerate settling, density determinations by the flotation method can be enhanced in accuracy, and smaller crystals may be employed. M. H. H.

HAUPTMANN (Heinrich) & SCHULZE (Gustav E. R.). *Über ein neues Mikrovolumenometer.* Zeits. Physikal. Chem., 1934, Abt. A, vol. 171, pp. 36–40, 2 figs.

An apparatus is described for the determination of the volume of small amounts of material. The substance is placed in a gas reservoir of known volume, and the gas volume at several pressures determined, whence the volume occupied by the substance may be deduced. An accuracy of 1 % with volumes of about 0·01 c.c. is claimed. The apparatus enables fairly accurate densities of small amounts of substances too heavy for flotation to be determined. M. H. H.

IPS (E. M. H.) & SACK (J.). *A hardness tester for microscopical objects.* Nature, London, 1936, vol. 138, pp. 328–329, 2 figs.

A diamond with a pyramid-shaped point is fixed in a piston which can move freely in a cylinder fitted to the nosepiece of a microscope. A particular grain of a polished metallographic specimen is centred

with an appropriate objective. The hardness tester is then swun into position, and the dimensions of a square impression registere by the diamond under the weight of the piston in a given time ar afterwards measured with an ocular micrometer. The method ha so far been used to measure the relative hardness of crystals i aluminium alloys and steels, but has obvious applications to miner grains in rock-sections. F. A. B.

Wyckoff (Ralph W. G.) & Lagsdin (J. B.). *An improved self-rect fying gas X-ray tube.* Rev. Sci. Instruments (Amer. Ins Physics), 1936, vol. 7, pp. 35–37, 3 figs.

An X-ray tube of simple construction is described in which wa seals are replaced by lead sheet and fuse wire seals, thus permittin a greater energy input. A built-in slit system enables a mo intense beam to be utilized and also reduces the stray radiatio that is harmful to the operator. F. A. B.

Corey (Robert B.), Lagsdin (J. B.), & Wyckoff (Ralph W. G. *Line focus with a gas type X-ray tube.* Rev. Sci. Instrumen (Amer. Inst. Physics), 1936, vol. 7, p. 193, 1 fig.

The usual concave contour of the cathode of a gas X-ray tube modified by cutting a narrow transverse elliptical channel. More the X-rays generated in the tube can then be utilized both for line and pin-hole collimator slit systems. F. A. B.

Wooster (W. A.) & Martin (A J. P.). *An automatic ionizatio spectrometer.* Proc. Roy. Soc. London, Ser. A, 1936, vol. 15 pp. 150–172, 15 figs.

An apparatus has been constructed for setting a crystal and r cording automatically the X-ray diffractions from all the plan parallel to a given axis. Electrometer-triode valves are used t amplify and measure the ionization current, and the final recor are obtained on photographic paper. The total time taken t register the diffractions from fifty planes around one axis is s hours. F. A. B.

Bennewitz (K.). *Vorrichtung zur Justierung des Röhrchens bei Debye-Scherrer-Verfahren.* Zeits. Krist., 1935, vol. 90, pp. 55 560, 1 fig.

A mechanical device is figured and described for rapid an accurate centring of preparations for X-ray powder photographs. F. A. B.

FARLAN (Ronald L.). *Apparatus for X-ray patterns of the high pressure modifications of ice.* Rev. Sci. Instruments (Amer. Inst. Physics), 1936, vol. 7, pp. 82–85, 6 figs.

A special camera for observing the X-ray diffraction patterns of high-pressure modification of ice is described. The photographs re taken with the rotating specimen of ice at a temperature of 55° C., and after exposure the volume expansion of the specimen ring transition to ordinary ice was also observed. Patterns for II and ice VI are reproduced. F. A. B.

RN (John E.) & GLOCKLER (George). *A high temperature vacuum Debye-Sherrer X-ray camera.* Rev. Sci. Instruments (Amer. Inst. Physics), 1936, vol. 7, pp. 389–390, 2 figs.

A vacuum camera for X-ray powder photographs has been designed ilizing a thermocouple for accurate temperature measurement. variation of temperature after equilibrium has been established ss than 2° at 500° C. for periods up to 12 hours. F. A. B.

RN (John E.) & GLOCKLER (George). *A universal self-rectifying gas X-ray tube.* Rev. Sci. Instruments (Amer. Inst. Physics), 1936, vol. 7, pp. 391–393, 3 figs.

The chief difficulty in operating gas X-ray tubes with high energy lies in the insulator between anode and cathode. Voltage k-down of the seals has been overcome by the use of a glazed celain tube. F. A. B.

NTANO (J. C. M.). *An X-ray goniometer using beams of large aperture for photographically recording crystal-powder reflections.* Proc. Physical Soc. London, 1937, vol. 49, pp. 61–77, 2 pls., 3 text-figs.

he factors that determine the various aberrations of X-ray reflec- s from microcrystalline powders are considered, and expressions derived for those from flat, toroidal, and spherical surfaces in tion to the angular setting. Powder layers with spherical and idal surfaces make it possible to employ considerably wider ms with correspondingly shorter exposures, and an instrument is gned on these lines. L. J. S.

RGER (M. J.). *An X-ray powder camera.* Amer. Min., 1936, vol. 21, pp. 11–17, 5 figs.

ne needle carrying the powdered material is rotated by a motor e axis (placed horizontally) of the cylindrical camera 57·26 mm.

in diameter. X-rays enter by a pinhole system through the curv surface. A battery of four such cameras is set up around a Haddi X-ray tube. L. J. S.

Buerger (M. J.). *An apparatus for conveniently taking equi-incli tion Weissenberg photographs.* Zeits. Krist., 1936, vol. pp. 87–99, 1 pl., 5 text-figs.

An X-ray Weissenberg apparatus suitable for the equi-inclinati beam technique is described, and charts for setting the inclinati angle, &c., are reproduced. F. A. B.

Burgers (W. G.) & Ploos van Amstel (J. J. A.). *An apparatus "optical" demonstration of some geometrical features of elect diffraction photographs.* Zeits. Krist., 1936, vol. 95, pp. 54– 11 figs.

A description and pictures of an apparatus are given, suitable the explanation of diffraction phenomena to a lecture-room audier H. H.

Buerger (M. J.). *A device for drilling oriented holes in spheres requi in the construction of crystal structure models.* Rev. Sci. Inst ments (Amer. Inst. Physics), 1935, vol. 6, pp. 412–416, 4 fig

Buerger (M J.) & Butler (Robert D.). *A technique for the c struction of models illustrating the arrangement and packing atoms in crystals.* Amer. Min., 1936, vol. 21, pp. 150–1 9 figs.

The models are constructed of wooden balls of various sizes colours closely packed and held in position by metal pins, the s adopted being 1 inch = 2 Å. The atomic radii and atomic distan give data for the ρ and ϕ co-ordinates for drilling holes in the b on a special machine. The construction of models of the structu of marcasite and sulvanite is worked out in detail as examples. L. J. S.

Buerger (M. J.) & Lukesh (J. S.). *The preparation of orie polished sections of small single crystals.* Amer. Min., 19 vol. 21, pp. 667–669, 4 figs.

The crystal is cemented to a goniometer holder provided with hinged joints at right angles (instead of the usual arcs). A adjustment, this is placed in a clamp against a grinding disk cove

with emery paper and afterwards linen with chrome oxide. Crystals of opaque minerals (marcasite and danaite) so polished were photographed between crossed nicols. L. J. S.

WENTWORTH (Chester K.) & SUZUKI (Francis T.). *Multiple grinding of thin-section chips.* Amer. Journ. Sci., 1936, ser. 5, vol. 31, pp. 93–96, 1 fig.

An arrangement is described for the simultaneous grinding of a number of rock chips, producing slices ½ mm. thick, which are finished singly by the ordinary method. Six or eight chips are cemented on each of three brass disks, and these are attached to the underside of a frame which is supported over the grinding lap. L. J. S.

SMIGH (G. D.). *An improved Vanderwilt rock saw.* Amer. Min., 1936, vol. 21, pp. 670–675, 2 figs.; 1937, vol. 22, pp. 142–144, 2 figs.

Rock and mineral specimens are sawn with an iron blade worked by a small electric motor and fed with carborundum. L. J. S.

Mathematical Crystallography.

NIGGLI (Paul) & NOWACKI (Werner). *Der arithmetische Begriff der Kristallklasse und die darauf fußende Ableitung der Raumgruppen.* Zeits. Krist., 1935, vol. 91, pp. 321–335, 2 figs.

A further contribution to the theory of space-groups involving an arithmetical conception of the crystal-class. F. A. B.

HEITZ (F.). *A matrix-algebraic development of the crystallographic groups. II–IV.* Zeits. Krist., 1935, vol. 90, pp. 289–313; 1935, vol. 91, pp. 326–366; 1936, vol. 94, pp. 100–130.

The methods of the author's earlier paper [M.A. **6**–78] are applied to translation groups. H. H.

HAAG (F.). *Die den Zahlen von 1 bis 100 im kubischen Gitter zugeordneten Vielecke.* Zeits. Krist., 1935, vol. 90, pp. 456–466, 5 figs.

A table is given showing how each number from 1 to 100 can be expressed as the sum of three squares (e.g. $50 = 5^2+4^2+3^2 = 7^2+5^2+0^2 = 7^2+1^2+0^2$), and a geometrical method is discussed of finding the tetrahedral numbers of which the n-th is $\frac{1}{6}n(n+1)(n+2)$ or $\frac{1}{6}n(2n+1)(3n+1)$. H. H.

Reinicke (Richard). *Über einige hochsymmetrische, der Kugel einbeschriebene 120-Eckner.* Zeits. Krist., 1935, vol. 90, pp. 446–456, 12 figs.

Methods are given by means of which solids with 30, 32, 36, 48, 54, 56, 60, 72, 84, 96, 108, 120, 126, 128, or 134 vertices, having a high degree of symmetry, may be inscribed in a sphere. The method is worked out in detail in the case of four solids with 120 vertices. H. H.

Schafranowski (I. I.). *Die Verteilung polarer Distanzen in Kristallen mittlerer Syngonien.* Zeits. Krist., 1936, vol. 94, pp. 33–39, 4 figs.

The distribution of the polar distances, i.e. angles between face normals and axis of symmetry, for all known forms occurring in uniaxial crystals is shown graphically. When the curves are smoothed the most frequent angle for the trigonal, tetragonal, and hexagonal systems is found to be 55°, 54°, 54°. The material used consisted of 1429 forms on 631 substances, 1057 on 651, 488 on 512, for the three systems respectively. H. H.

Schaacke (Ingeburg). *Über die Zusammenhänge im hexagonalen Atomgitter und reziproken Gitter bei viergliedriger Symbolisierung.* Zeits. Krist., 1935, vol. 91, pp. 466–472, 1 fig.

Formulae are obtained connecting the four symbols which give the position of face or zone in a hexagonal lattice and in the reciprocal lattice. H. H.

Ungemach (H.) [1880?–1936]. *Sur les avantages de l'emploi de notations à qudtre caractéristiques pour les cristaux de symétrie rhomboédrique.* Zeits. Krist., 1935, vol. 91, pp. 97–113, 3 figs.

The author pleads for the use of the four-index notation, introduced by Bravais and universally adopted for hexagonal crystals, when rhombohedral crystals also are under consideration. H. H.

Buerger (M. J.). *The application of plane groups to the interpretation of Weissenberg photographs.* Zeits. Krist., 1935, vol. 91, pp. 255–289, 31 figs.

A plane point-group and a plane translation-group are defined and criteria for their recognition in Weissenberg photographs are given. Hence it is shown how the reciprocal lattice of a crystal may be investigated directly by the Weissenberg method. The author

ork is more general in its treatment than that of Miss D. Crowfoot [M.A. **6**–166]. F. A. B.

ATTERSON (A. L.). *A direct method for the determination of the components of interatomic distances in crystals.* Zeits. Krist., 1935, vol. 90, pp. 517–542, 9 figs.

——*Tabulated data for the seventeen plane groups.* Ibid., pp. 543–554, 22 figs.

The theory of Fourier series is applied to the direct determination the components of interatomic distances in crystals, potassium hydrogen phosphate, hexachlorobenzene, and copper sulphate pentahydrate being taken as illustrations. The second paper tabulates formation required for the application of the methods used in the rst paper. H. H.

ACOCK (M. A.). *Cyclic permutation of crystallographic axes.* Amer. Min., 1936, vol. 21, p. 136.

An interchange of crystallographic axes is not correctly described an inversion or a transposition; permutation is suggested.

L. J. S.

ERGER (M. J.). *The law of complication.* Amer. Min., 1936, vol. 21, pp. 702–714.

A discussion of the occurrence and indices of crystal faces in zones. further complication is introduced by proposing to rename this the aw of permutable axes'. L. J. S.

OISI (P.). *On the application of determinants to crystallography.* Amer. Min., 1935, vol. 20, pp. 400–401. [Cf. M.A. **6**–80.]

Priority is claimed for Q. Sella, 1858. The method has since been ich used in Italy. Reply by J. D. H. Donnay, ibid., pp. 601–602.

L. J. S.

OGERS (Austin F.). *A tabulation of crystal forms and discussion of form-names.* Amer. Min., 1935, vol. 20, pp. 838–851.

The various names for the 48 possible open and closed crystal-rms are discussed, and preference is given to those of Fedorov and oth. L. J. S.

LDYREV (A. K.). *Are there 47 or 48 simple forms possible on crystals?* Amer. Min., 1936, vol. 21, pp. 731–734.

The statement of A. F. Rogers (preceding abstract) that there are simple crystal-forms is controverted. His 'dome' and 'sphenoid' sisting of two intersecting faces are identical, and now called a

dihedron. The names adopted for the 47 forms are based on th geometrical shapes, e.g. monohedron (= pedion), trigon-trioctahedr (= triakis-octahedron), tetragon-trioctahedron (= icositetrahedron trapezohedron), &c. L. J. S.

McNabb (Wallace M.) & McNabb (Josephine W.). *Guide for crys drawing.* Journ. Franklin Inst. Philadelphia, 1936, vol. 2 pp. 539–546, 1 fig.

Instructions are given for drawing crystals from the gnomo projection. When representing the actual form of small cryst preliminary camera lucida drawings are recommended [M.A. **5**–34 L. J. S.

Physical Properties.

Payne (C. J.), Franklin (L.), & Anderson (B. W.). *The use Clerici solution for density determinations.* Gemmologist, Lond 1936, vol. 5, pp. 274–279, 1 fig.

A plot of the density against refractive index of Clerici solut (thallium formate and malonate in water) gives a nearly strai line. The extreme values here given are d 3·244, n_D 1·5778 d 3·884, n_D 1·6535. The density of a gemstone can be quickly de mined by measuring the refractive index of the liquid in which i just suspended. [Cf. M.A. **2**–487; **4**–450; **5**–427.] L. J. S.

Tertsch (H.). *Schleifhärtenanisotropie am Baryt.* Zeits. Kr 1936, vol. 95, pp. 296–307, 2 figs.

Methods employed to investigate the hardness of calcite and d mite in different directions [M.A. **6**–74, 280] were adapted to measurement of the hardness of baryte on the base and prism cleava planes. H. E.

Wooddell (Charles E.). *Method of comparing the hardness of ele furnace products and natural abrasives.* Trans. Electrochem. S New York, 1936, vol. 68, pp. 111–137, 3 figs.

Different materials were embedded in resin and several mou together on a disk applied to a grinding lap. The thickness material removed were measured with a micrometer. Taking qu as 7 and corundum as 9, the following values were obtai Brazilian brown bort 42·4, Brazilian ballas 42·0, Belgian Co yellow diamond cube 41·0, Belgian Congo clear white diamond 40·7, Belgian Congo grey opaque diamond cube 38·7, Brazilian bonado 36·4, boron carbide 19·7, black silicon carbide 14·0, g

ilicon carbide 13·4, tungsten carbide (with 13 % Co) 12·0, fused lumina (with 3·14 % TiO_2) 11·0, fused alumina ('A') 11·0. [Cf. M.A. -369; **6**–279.] L. J. S.

CHULER (M.) & DIMPKER (A.). *Über die Druckfestigkeit von Kristallen.* Zeits. Instrumentenkunde, Berlin, 1935, vol. 55, pp. 63–70, 10 figs.

Spheres of artificial and native sapphire and ruby, of 4 mm. radius, n a plate of the same material, show the first crack under a load of 0 kg. and are broken with 160 kg. With spheres of 1 mm. radius he corresponding loads were 10 and 40 kg. Tests were also made ith balls of quartz and steel, and with conical points of sapphire nd diamond. L. J. S.

HAMBERS (Bruce). *Micro-plasticity of crystals of tin.* Proc. Roy. Soc. London, Ser. A, 1936, vol. 156, pp. 427–443, 6 figs. [Cf. M.A. **6**–281.]

Single-crystal rods of tetragonal tin under a low tension show a icro-creep of 3×10^{-9} cm./cm./min. per gm. wt./sq. mm. Above a ress of 120 gm. wt./sq. mm. the creep is more rapid (macro-creep) nd slip-bands are then evident. L. J. S.

OMAR (A.). *Calculation of the Laue patterns from plastically bent crystals of NaCl.* Zeits. Krist., 1936, vol. 94, pp. 22–32, 7 figs.

Making suitable hypotheses as to what takes place during the nding of a rod of rock-salt, it is possible to calculate mathemati-lly the nature of the Laue picture for such a bent crystal. The sult is compared with the picture obtained by experiment, and isfactory agreement between theory and observation is obtained. H. H.

ANI (Kôichi). *Viscosity phenomena of the system $KAlSi_3O_8$–$NaAlSi_3O_8$ and of perthite at high temperatures.* Proc. Imp. Acad. Tokyo, 1935, vol. 11, pp. 334–336, 2 figs.

ŌZU (Shukusuké) & KANI (Kôichi). *Viscosity measurements of the ternary system diopside–albite–anorthite at high temperatures.* Ibid., pp. 383–385, 2 figs.

Using the rotating cylinder method [M.A. **5**–509], the viscosity was termined for fusions of orthoclase and albite in various proportions 1300–1450° C. The viscosity increases with the amount of ortho-se present and decreases with higher temperature. Results are ven for the systems Ab–An, Ab–Di, An–Di, and Ab–An–Di at 50°–1575° C. L. J. S.

Hill (Donald M.). *The principal expansion coefficients of singl crystals of mercury.* Physical Rev. (Amer. Physical Soc.), 1935 vol. 48, pp. 620–624, 5 figs.

A method of growing single crystals of mercury in the form c cylindrical rods is described. Their expansion coefficients wer measured from −115° to −160° at 5° intervals and more approxi mately from −160° to −190° C. The expansion coefficient paralle to the trigonal axis is the larger and increases more rapidly wit temperature. F. A. B.

Kossolapow (G. F.) & Trapesnikow (A. K.). *Röntgenographisch Bestimmung der thermischen Ausdehnungskoeffizienten von Bery lium und Zinn.* Zeits. Krist., 1936, vol. 94, pp. 53–59, 2 figs

The size of the unit cell was measured for beryllium at the temper tures 18°, 220°, 320°, 454° C. and for tin at 23°, 120°, 150° C. in ord to determine the coefficients of expansion of those substances.

H. H.

Schnaase (H.). *Über die Änderung des Achsenverhältnisses und d Lage des rhombischen Schnittes mit der Temperatur beim Anorth vom Vesuv.* Zeits. Krist., 1936, vol. 93, pp. 444–463, 4 figs.

The crystallographic constants of anorthite from Vesuvius we measured for temperatures varying from room-temperature to 973° The application of the results to determination of temperatures geological history is suggested. H. H.

Krishnan (K. S.) & Banerjee (S.). *Investigations on magne-crystal action. III—Further studies on organic crystals.* Phil. Tran Roy. Soc. London, Ser. A, 1935, vol. 234, pp. 265–298, 2 fig [M.A. **6**–285.]

—— —— *IV—Magnetic behaviour of paramagnetic ions in the S-st in crystals.* Ibid., 1936, vol. 235, pp. 343–366, 1 fig. [M.A. 350; **6**–77.]

The second paper gives data of the magnetic anisotropy and orient tion of a number of Tutton salts and other double manganous a ferric salts with alkalis. L. J. S.

Wooster (W. A.). *Thermal conductivity in relation to crystal structu* Zeits. Krist., 1936, vol. 95, pp. 138–149, 5 figs.

A formula is given connecting crystal structure with anisotropy thermal conductivity which gives results in accordance with expe

ent in the case of rutile, corundum, anhydrite, zircon, and urea. he connexion between structure and conductivity is also discussed r thirteen other substances. H. H.

ONSDALE (Kathleen) & KRISHNAN (K. S.). *Diamagnetic anisotropy of crystals in relation to their molecular structure.* Proc. Roy. Soc. London, Ser. A, 1936, vol. 156, pp. 597–613, 2 figs. [Cf. M.A. **6**–285.]

The configuration and orientation of the molecules of an organic bstance can only in a few cases be determined directly from X-ray ta. Measurements of the optical and diamagnetic anisotropy of crystal may, however, yield directly the shape and orientation of e molecules. A summary is given for the different crystal systems the mathematical relations between crystal and molecular diagnetic susceptibilities and molecular orientations. Only for subnces belonging to the cubic system can no information concerning molecular orientations be obtained from magnetic measurements. F. A. B.

BBS (Reginald E.) & TSIEN (Ling-Chao). *The production of piezoelectricity by torsion.* Phil. Mag. London, 1936, ser. 7, vol. 22, pp. 311–322, 6 figs.

Solid and hollow cylinders of quartz cut with their axes parallel the optic axis produced electricity when submitted to torsion. L. J. S.

QUÉRÉ (Henri). *Sur un appareil propre à déceler la pyroélectricité.* Bull. Soc. Franç. Min., 1936, vol. 59, pp. 137–142, 3 figs.

An apparatus is described for determining the pyroelectric effect of all crystals. The specimen connected to the needle of a quadrant ctrometer is totally enclosed within a metal chamber at earth ential. A true pyroelectric effect is checked by the reversal of ential when the enclosing chamber is cooled, rather than heated, when the specimen is reversed in position. Specimens of topaz, lecite, mesolite, prehnite, and axinite are hemihedral, but no oelectric effect was observed for dioptase. F. A. B.

RBAUMOW (N. J.) & JENSCH (R. G.). *Über die Temperaturabhängigkeit des umgekehrten Photoeffektes an Kupritkristallen.* Physikal. Zeits. Sowjetunion, Charkow, 1936, vol. 9, pp. 345–351, 3 figs.

The influence of temperature on the Dember effect in cuprite stals has been studied from −55° to +84° C. F. A. B.

Balyi (Károly). *A nyomás és melegités hatása a galenitre.*—Baly (Karl). *Über das Verhalten der Bleiglanzkristalle bei einseitige Druck und im Wärmestrom.* Földtani Közlöny, Budapest, 193 vol. 65, pp. 153–162, 3 figs. (German with Hungarian summary

The intensity of the electric current produced by lateral pressu in galena is represented by a parabolic curve. Those crystals th give a current in the direction of the pressure also generally give t the conduction of heat a current in the same direction. Those th give by pressure a current in the opposite direction also give by he conduction a current in the opposite direction. This holds good 68 % of the experiments. Crystals of pyrite show the same phen mena. V. Z.

Landau (L.) & Lifshitz (E.). *On the theory of the photoelectromoti force in semiconductors.* Physikal. Zeits. Sowjetunion, Charko 1936, vol. 9, pp. 477–503, 3 figs.

A theoretical discussion of the Dember effect. The photoelectr motive force is calculated for (1) a semiconductor with conducti electrons, and (2) a semiconductor with conducting electrons a 'holes' that also play a part in the conductivity. Only the latt type of conduction has so far been observed experimentally.

F. A. B.

Ideal- und Realkristall. Diskussionsbeiträge. Zeits. Krist., 193 vol. 93, pp. 161–228, 8 figs.

A discussion by various workers of papers previously published physical problems of crystallization phenomena. [M.A. **6**–73, 76, 7

F. A. B.

Crystal-optics.

Saylor (Charles Proffer). *Accuracy of microscopical methods determining refractive index by immersion.* Journ. Resear National Bureau Standards [U.S.A.], 1935, vol. 15, pp. 277–2 10 figs.

The accuracy attainable in refractive index determinations by t immersion method (assuming that errors in the determination of t refractive index of the matching liquid, including those due to te perature variation, are avoided) depends greatly on the nature o the material and on the objectives and methods employed. T greatest accuracy is attained with particles having surfaces perp dicular to the slide, and the least with lenticular particles. Accura

greater the lower the numerical aperture of the objective used, provided that the limits of resolution are not passed. The Becke (central illumination method) is better than the ordinary oblique illumination method, and a modification of the double-diaphragm method of Wright is better still. With birefringent substances, care should be taken that the vibration-direction for the index under determination is normal to the plane containing the oblique rays effective in producing the Becke line. The error due to failure to observe this latter condition may be very serious with the ordinary oblique illumination method (an error amounting to 20% of the birefringence is recorded). With proper conditions and particles of 0 to 100 μ diameter the error of the determination can be brought low as 0·0001, while with unsuitable objectives and methods it may be impossible to get nearer than 0·001. Smaller particles necessitate the use of a higher power objective, lowering the accuracy; with glass spheres of diameter 2 μ the accuracy is reduced by a factor of about 5. M. H. H.

LAWSON (Chester B.) & PECK (A. B.). *The determination of the refractive indices of minerals by the immersion method.* Amer. Min., 1936, vol. 21, pp. 523–528, 1 fig.

When the orientation of a fragment has been found from the interference-figure, the principal indices can be determined. This is better than the statistical method of determining the maximum and minimum indices in a large number of fragments, the orientation of which may be influenced by cleavage. L. J. S.

UTTGENBACH (H.). *Mesure de l'angle des axes optiques et détermination du signe optique à l'aide du réfractomètre.* Bull. Cl. Sci. Acad. Roy. Belgique, 1936, ser. 5, vol. 22, pp. 125–133, 2 figs.

— *Sur une nouvelle méthode de mesure de l'angle des axes optiques dans une lame parallèle au plan des axes.* Bull. Soc. Géol. Belgique, 1936, vol. 59, pp. B 210–B 211.

A crystal plate parallel to the optic axial plane (e.g. a cleavage plate of euclase or the (010) cleavage of anhydrite) gives on the refractometer the extreme values for α and γ, and as it is rotated the two shadow lines approach and coincide along the trace of an optic axis, then giving the index β. The angle through which the plate has been rotated gives the optic axial angle and the sign of the crystal. L. J. S.

West (C. D.). *Immersion liquids of high refractive index.* Amer. Min., 1936, vol. 21, pp. 245–249, 2 figs.

A mixture of yellow phosphorus, sulphur, and methylene iodide gives a liquid with n_D 2·06 and dispersion $n_F - n_C$ 0·065 at 25° C., miscible in all proportions with methylene iodide (n_D 1·74, $n_F - n_C$ 0·038 at 15° C.). When kept under water in the dark it is stable, and it is convenient to use. L. J. S.

Swaryczewski (A.). *Konoskopowe oznaczenie położeń binormalnych w krysztale trójskośnym bez oznaczania spółczynnika n_β.—La détermination conoscopique de la position des axes optiques dans un cristal triclinique sans connaissance de l'indice n_β.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1936, vol. 12, pp. 1–5 (Polish), p. 6 (French résumé), 3 figs.

The method of Wülfing (1902) requires a knowledge of the value of n_β. The angles made by the optic axes with the normals to two crystal plates are measured, from which 2V can be calculated. Measurements were made on zinc silico-tungstate, $2ZnO.12WO_3.SiO_2.18H_2O$. L. J. S.

Dodge (Theodore A.). *A rapid microscopic method for distinguishing quartz from untwinned oligoclase-andesine.* Amer. Min., 1936, vol. 21, pp. 531–532.

Quartz, being uniaxial, when placed in the extinction position remains so when rotated on the universal stage in the plane of the polarizer or of the analyser. L. J. S.

Penta (Francesco). *L'impiego del cuneo di quarzo per la determinazione delle lunghezze d'onda di luci monocromatiche.* Periodico Min. Roma, 1936, vol. 7, pp. 187–192, 1 fig.

Determination of the wave-length of monochromatic light with a quartz wedge. L. J. S.

Donnay (J. D. H.). *La biréfringence de forme dans la vaterite.* Ann. (Bull.) Soc. Géol. Belgique, 1936, vol. 59, pp. B 215–B 222, 1 fig.

—— *Le* [sic] *biréfringence de forme dans la calcédoine.* Ibid., pp. B 289–302, 5 figs.

Vaterite-*A* has been identified with calcite and vaterite-*B* with μ-$CaCO_3$ [M.A. **1**–166, **3**–168]. The wide differences between the refractive indices of vaterite-*A* and calcite are explained by the 'form birefringence' of the fibres composing the minute spherulite

vaterite-*A*. The differences in the case of vaterite-*B* and μ-$CaCO_3$ e too small for the application of the formulae of O. Wiener (1912). The lower refractive indices given by chalcedony fibres, which are uartz crystals elongated parallel or perpendicular to the vertical is, can be explained by the admixture of opal. The data given by rrens and Nagelschmidt [M.A. **5**–381] are adapted to the formulae Wiener. L. J. S.

KPAPETROU (A.). *Vereinfachte Berechnung der strukturellen Doppelbrechung.* Zeits. Krist., 1936, vol. 94, pp. 80–85, 2 figs.

A theoretical expression is derived for the double refraction of a bstance crystallizing with an orthogonal lattice. F. A. B.

OLLARD (A. F. C.). *Polarization of light and some technical applications.* Nature, London, 1936, vol. 138, pp. 311–314.

Highly pleochroic quinine iodosulphate, $4Qu.3H_2SO_4.2HI.I_4.6H_2O$ rapathite) can be obtained only as minute crystals, but these can oriented in viscous nitrocellulose or cellulose acetate solutions by chanical or electrical means. The resulting sheets of 'polaroid' ssess the property of polarizing light, and data are given for the centage polarization and percentage transmission of these screens wave-lengths over 3000 Å. The important applications of laroid' are outlined and the relation to the photoanisotropic ect noted. F. A. B.

RTIN (R.). *Courbes de dispersion des pouvoirs réflecteurs de quelques tellurures naturels.* Compt. Rend. Acad. Sci. Paris, 1937, vol. 204, pp. 598–599.

By means of an improved photoelectric method [M.A. **5**–206] the ecting powers for eight different wave-lengths were determined petzite, coloradoite, nagyagite, sylvanite, calaverite, and hessite. three first exhibit normal dispersion, calaverite and sylvanite ormal, while the reflecting power of hessite is practically indedent of wave-length. [M.A. **5**–344.] C. A. S.

RGSTRÖM (L. H.). *Die Fluoreszenz finnischer Mineralien in ultraviolettem Licht.* Bull. Comm. Géol. Finlande, 1936, no. 115 (= Compt. Rend. Soc. Géol. Finlande, no. 9), pp. 349–355.

A list is given of various minerals from Finland noting their rescent effects in ultra-violet rays. The strongest fluorescence hown by calcite, fluorite, wollastonite, and scheelite. L. J. S.

Chemical Crystallography.

Donnay (J. D. H.) & Mélon (J.). *Crystallo-chemical tables for th determination of tetragonal substances.* Studies in Geology, John Hopkins University, Baltimore, 1934, no. 11, pp. 305–388.

The systematic recalculation and setting of all the tetragona compounds listed in P. Groth's 'Chemische Krystallographie', an of a considerable number measured since, has been carried out i accordance with the determinative scheme proposed by T. V. Barke [M.A. **4**–337], and the compounds are now listed in order of classifi cation angle, together with some other determinative data. The lis are remarkably free from errors or misprints. [A similar list h been compiled independently by the abstractor and agrees almo perfectly.] M. H. H.

Boldyrew (A. K.) & Doliwo-Dobrowolsky (W. W.) [1904–1936] *Über die Bestimmungstabellen für Kristalle.* Zeits. Krist., 193 vol. 93, pp. 321–367, 19 figs.

The methods of crystal determination employed by Fedoro Barker, Goldschmidt, and others are reviewed as an introduction to description of the nature and use of a table prepared by the autho with a key enabling any crystal to be identified from goniometri measurements and its structure and physical properties obtaine The first volume is just ready and contains 1871 uniaxial substance [Cf. M.A. **3**–159.] H. H.

Donnay (J. D. H.). *Über die Bestimmungstabellen für Kristal* Zeits. Krist., 1936, vol. 94, pp. 410–412.

An answer to criticisms made by A. K. Boldyrew and W. V Doliwo-Dobrowolsky (preceding abstract). H. H.

Boldyrev (A. K.). *Über die Bezeichnung polymorpher Modifikatione* Min. Petr. Mitt. (Tschermak), 1936, vol. 47, pp. 517–522, 1 f

Four different notations for polymorphic modifications are note and the one which gives α, β, γ in the chronological order of the d covery of each modification is recommended. For example, α-quar (low-quartz, quartz$_{-575}$, β-quartz of Boeke) and β-quartz (high-quar quartz$_{+575}$, α-quartz of Boeke). H. E. Boeke's notation, according the order of lower temperature stability, is not practicable when the are several modifications, as with ice and sulphur. L. J. S.

BRIDGMAN (P. W.). *Polymorphism, principally of the elements, up to 50,000 kg/cm².* Physical Rev. (Amer. Physical Soc.), 1935, vol. 48, pp. 893–906, 13 figs.

An apparatus is described for applying pressures up to 50,000 kg/cm² to solids. New polymorphous forms have been found for bismuth, mercury, thallium, tellurium, gallium, and iodine. The chloride, bromide, and iodide of potassium undergo a change above 30,000 kg/cm² from the rock-salt probably to the caesium chloride structure type. F. A. B.

BORCHERT (W.). *Über die Mannigfaltigkeit polymorpher Umwandlungsvorgänge am Kaliumnitrat in ihrer gegenseitigen Bedingtheit.* Zeits. Krist., 1936, vol. 95, pp. 28–53, 1 pl., 2 text-figs.

Potassium nitrate exists in a low-temperature orthorhombic form (β) of aragonite type and a high-temperature trigonal form (α) of calcite type. The form β passes into α at 128° C. when the temperature rises. When the temperature falls the transition begins at 123° C. and is completed at 113° C. H. H.

BERLINGER (E.). *Atom- und Ionenwirkungsradien II.* Zeits. Krist., 1936, vol. 93, pp. 399–408, 7 figs.

Tables are given comparing the radii of atoms and cations of the chemical elements. H. H.

BIFERT (H.). *Die anomalen Mischkristalle.* Fortschr. Min. Krist. Petr., 1935, vol. 19, pp. 103–182, 16 figs.; 1936, vol. 20, pp. 324–455, 24 figs.

'Anomalous mixed crystals' are those in which colouring matter and various impurities are included [M.A. **4**–301, 302], as distinct from normal mixed crystals or solid solutions. Both of these groups are considered from a physical-chemical standpoint and the growth of 'real' crystals. Regular groupings of crystals of different kinds and adsorption on crystal faces are also dealt with in detail. Many (343) references are given to the literature. L. J. S.

BORRIEZ (Paul). *Sur quelques propriétés du graphite provenant de la transformation du diamant.* Compt. Rend. Acad. Sci. Paris, 1936, vol. 202, pp. 59–61.

X-ray examination of graphite formed by heating diamond at 2000° indicates the presence of much better developed crystallites than those formed in sugar carbon by heating at 2000°. Its electrical resistance, though substantially less than that of the sugar carbon, is

still considerably greater than that of Madagascar graphite, while the magnetic susceptibility approximated to that of the sugar carbon.

C. A. S.

Levi (G. R.) & Baroni (A.). *Struttura del carbonio ottenuto per disidratazione di idrati di carbonio (inosite, quebracite, glucosio).* Zeits. Krist., 1936, vol. 93, pp. 156–157, 3 figs.

Carbon obtained by dehydration of glucose with $ZnCl_2.HCl$ at 200° is practically amorphous. Carbon obtained similarly from quebracite and inosite has the structure of graphite. H. H.

Serra (Aurelio). *Osservazioni sulla cristallizzazione dell' anidride arseniosa.* Zeits. Krist., 1935, vol. 90, pp. 471–472.

When monoclinic or cubic As_2O_3 is dissolved or vaporized and then crystallized or sublimed under the same conditions, the original modification reappears. This points to a difference between the two modifications which is preserved during the process of solution or vaporization. H. H.

Serra (Aurelio). *Cristallografia chimica: Osservazioni sulla cristallizzazione dell' anidride antimoniosa.* Zeits. Krist., 1935, vol. 91 pp. 371–372.

When Sb_2O_3 is crystallized from water or sulphuric acid, optically biaxial modifications appear above 100° C. but cubic crystals below that temperature. H. H.

Sztrókay (K.). *Kristallographische Verhältnisse des Aluminiumjodatnitrats.* Zeits. Krist., 1935, vol. 90, pp. 381–382, 1 fig.

Aluminium iodate-nitrate crystallizes in the class C_{3i} with $a:c=1:1{\cdot}2056$. It has no cleavage. Twinning on the plane $(10\bar{1}1)$ is found on small crystals. The refractive indices in sodium-light are ω 1·6516 and ϵ 1·6987. The composition is $Al(IO_3)_2.NO_3.6H_2O$, no water being lost on heating to 100° C. or on desiccation with P_2O_5. H. H.

Klasens (H. A.), Perdok (W. G.), & Terpstra (P.). *Crystallography of magnesium-sulphite, cobalt-sulphite and nickel-sulphite.* Zeits. Krist., 1936, vol. 94, pp. 1–6, 5 figs.

The trigonal substances $MgSO_3.6H_2O$, $CoSO_3.6H_2O$, and $NiSO_3.6H_2O$ have densities 1·725, 2·011, 2·027 and crystallographic axial ratios $a:c=1:1{\cdot}0287$, $1:1{\cdot}004$, $1:1{\cdot}012$, respectively. They are optically

uniaxial negative with ω 1·524, 1·553, 1·552 and ϵ 1·474, 1·506, 1·509 pproximately. Their space-group is C_3^4. H. H.

ONNAY (J. D. H.) & MÉLON (J.). *Crystallography of lithium molybdotellurate.* Amer. Min., 1936, vol. 21, pp. 125–127, 1 fig.

The crystals, with the composition $3Li_2O.TeO_3.6MoO_3.13H_2O$, have he form of acute rhombohedra with angle (100) : (010) = 104° 12′ :c = 1 : 1·9150). With this angle the greatest reticular density is n the basal plane. Sp. gr. 2·2, ω 1·703, ϵ 1·612. L. J. S.

ONNAY (J. D. H.) & MÉLON (J.). *Crystallography of ammonium molybdo-ditellurate.* Amer. Min., 1936, vol. 21, pp. 250–257, 5 figs.

The monoclinic crystals, $a:b:c$ = 1·8912 : 1 : 1·0731, β = 64° 22′, re rhombic plates flattened on (001) and with (100) cleavage. They re homeomorphous, but of very different habit, with ammonium ienate, ammonium molybdate, potassium tungstate, &c. Optical ata are given. L. J. S.

ONNAY (J. D. H.) & MÉLON (J.). *Crystallography of caesium molybdotellurates.* Amer. Min., 1936, vol. 21, pp. 299–311, 5 figs.

Two types of triclinic crystals showing a tendency towards homeomorphism are described: (1) equant and optically positive, (2) tabular and optically negative. L. J. S.

OßNER (B.) & BEßLEIN (J.). *Über wasserhaltige schwefelsäure Salze dreier Metalle.* Zentr. Min., Abt. A, 1934, pp. 358–364.

Further salts of the voltaite series [M.A. **4**–272; **5**–208, 452] are repared, namely (nos. 19–22) K-Zn-voltaite, Am-Co-voltaite, Rb-Coltaite, and Rb-Mg-voltaite, with the general formula $R'R''Fe'''$ $O_4)_3.4H_2O$, but with slight variations. Another series of optically nomalous cubic crystals is given by Li-Mn-Fe‴ and Na-Mn-Fe‴ lphates with the probable general formula $R'R''_4Fe'''(SO_4)_6.8H_2O$. L. J. S.

ELLOR (D. P.) & QUODLING (Florrie M.). *Crystallographic and optical data for Cs_2CuCl_4.* Zeits. Krist., 1936, vol. 95, p. 315, 2 figs.

The bright yellow Cs_2CuCl_4 is orthorhombic with crystallographic tios 0·7855 : 1 : 0·6141. The principal refractive indices are 1·625, 648, 1·678, the crystals being biaxial positive with (100) as optic ial plane. H. H.

Rosický (Vojtěch). *O směsných krystalech chloridu draselného sodného.* [On mixed crystals of potassium and sodium chloride.] Věda Přírodní, Praha, 1936, vol. 17, pp. 189–191, 2 figs.

Native and artificial crystals of NaCl are coloured yellow b cathode rays and KCl reddish-violet. Parallel overgrowth of the tw chlorides may be readily distinguished in this way. The coloratio of isomorphous mixed crystals obtained by fusion is, however, un form, and depends on the relative amounts of the two chlorides.

F. S.

Šplíchal (Jaroslav), Škramovský (Stanislav), & Goll (Jaroslav) *Tepelný rozpad uhličitanových nerostů.* [Thermal decompositio of carbonate minerals.] Věda Přírodní, Praha, 1936, vol. 1 pp. 206–213.

The influence of grain-size and surface was investigated in a ne type of electric furnace for calcite, magnesite, and dolomite. Th reaction curves are continuous, and no basic carbonates are forme during the decomposition. The reaction velocity is expressed b $dn/dt = Kn^{\frac{2}{3}}$ for magnesite and $dn/dt = Kn^{\frac{1}{3}}$ for calcite and dolomit where n is the loss of CO_2 in grams and t time in seconds. F. S.

Széki (J.) & Romwalter (A.). *Die Strukturformel des Enargits.* soproni m. kir. Bányamérnöki és Erdőmérnöki Főiskola bány szati és kohászati osztályának Közleményei (Mitt. d. berg- hüttenmänn. Abt. an d. kgl. ung. Hochschule f. Berg- u. Fors wesen zu Sopron), 1933, vol. 5, pp. 57–60.

Decomposition of enargite by concentrated solutions of caust alkalis at low temperature proves it to be a cuprothio-orthoarsena of the structure $(Cu-S)_3 \equiv As=S$. V. Z.

Hevesy (G. v.). *Materietransport in festen Körpern.* Zeits. Elektr chem., 1933, vol. 39, pp. 490–500, 4 figs.

The phenomena of diffusion in crystals are discussed, theoreti formulae proposed, and compared with experimental data (most for metals and halides). Diffusion falls into two classes: the mo important is diffusion by interchange, two atoms or groups in adjace lattice positions interchanging places; less frequent is diffusion in vacant lattice positions or through the interspaces of an open latti The rapid migration of the blue colour of blue rock-salt under t action of an electric field is a migration of electrons only, not atoms. M. H. H.

EILMANN (W.) & WÜNNENBERG (E.). *Durch Diffusion erhaltene, farbechte, permanganathaltige Bariumsulfatkristalle.* Zeits. Anorg. Chem., 1927, vol. 159, pp. 271–272, 1 pl.

Large (ca. 1 mm.), transparent, deep violet crystals of barium ulphate containing 4·9 % $KMnO_4$ were prepared by a diffusion ethod. The $KMnO_4$ cannot be removed by washing or reagents, ven when the crystals are finely powdered. M. H. H.

ENRATH (A.) & SCHACKMANN (H.). *Über scheinbare Mischkrystalle. I.* Zeits. Anorg. Chem., 1934, vol. 218, pp. 139–145, 4 figs.

Attempts were made to prepare mixed crystals of $BaSO_4$–$KMnO_4$ nd of $CaCO_3$–$NaNO_3$ by digestion of the less soluble salt in a solu- on of the more soluble, without success. True mixed crystals annot exist in these systems. M. H. H.

RIMM (H. G.) & WAGNER (G.). *Bemerkungen zu der Arbeit: „Über scheinbare Mischkristalle. I." von A. Benrath und H. Schackmann.* Zeits. Anorg. Chem., 1934, vol. 220, pp. 31–32.

It is emphasized that the fact that $KMnO_4$–$BaSO_4$ mixed crystals re not in equilibrium with the mother-liquor does not disprove eir mixed-crystal nature. Explanation by inclusions or inner sorption is impossible for crystals containing over 80 mols. % MnO_4. X-ray photographs show sharp lines intermediate in sition between those of $KMnO_4$ and those of $BaSO_4$, proving that e true mixed crystals were obtained. M. H. H.

ENRATH (A.) & SCHACKMANN (H.). *Über die Bedeutung anomaler kristallisierter Mischsysteme für die Bestimmung des Gleichgewichtes in gemischten Salzlösungen.* Zeits. Anorg. Chem., 1935, vol. 221, pp. 418–422.

When any salt crystallizes rapidly from a supersaturated solution ntaining a second salt it is liable to carry down some of the second lt. The crystals obtained are classed as anomalous mixed crystals; e mere possibility of the preparation of mixed crystals is hence no roof of isomorphism (true mixed-crystal formation). M. H. H.

ARAOGLANOV (Z.). *Über den Mechanismus von Fällungsvorgängen. XVI. Zur Kenntnis des $KMnO_4$-haltigen $BaSO_4$.* Zeits. Anorg. Chem., 1935, vol. 222, pp. 249–256.

A study of $BaSO_4$–$KMnO_4$ crystals prepared by precipitation leads the conclusion that they are true mixed crystals. M. H. H.

Hägg (Gunnar). *Solid solutions with a varying number of atoms in the unit cell.* Zeits. Krist., 1935, vol. 91, pp. 114–122.

Three main types of solid solution are discussed. (1) Interstitial solutions of neutral atoms or groups, e.g. metallic hydrides, borides, carbides, and nitrides; and zeolites. (2) Interstitial solution accompanied by substitution, e.g. spinels. (3) Interstitial solution accompanied by changes in valency, e.g. magnetite $Fe_3O_4 \rightarrow$ ferromagnetic ferric oxide γ-Fe_2O_3. In types 2 and 3 the variation in the number of atoms in the unit cell obeys the condition of electrostatic neutrality. Measurements of electric conductivity also afford evidence whether a solid solution of type 2 is an addition or subtraction compound. F. A. B.

Balarew (D.). *Die Übertragung der Oberflächenveränderungen in das Innere des Kristalls. III.* Kolloid-Zeits., 1934, vol. 66, pp. 317–322.

The catalytic effect of MnO_2 on the decomposition of $KClO_3$ is attributed to surface alterations due to the contact of the two substances, which can be transmitted into the interior of the crystal. Attempts to measure a thermal effect of the mixing of two crystalline powders failed. Large crystals of $KClO_3$ on decomposition lead to transparent anisotropic pseudomorphs of KCl [!]. M. H. H.

Balarew (D.). *Der mosaikartige Bau der Realkristalle und die Lehre über das heterogene Gleichgewicht.* Kolloid-Zeits., 1934, vol. 68, pp. 266–271.

Experiments showed a small variation in the vapour pressure of certain salt hydrates with the history of the sample, and according to whether measurements are made during hydration or during dehydration. The effects are explained and adduced as evidence in support of mosaic structure. M. H. H.

Balarew (D.). *Der disperse Bau der Mischkristalle.* Kolloid-Zeits., 1934, vol. 68, pp. 33–36, 8 figs.

The temperature of incipient volatilization or incipient decomposition has been measured for several mixed crystals in which only one component is volatile or liable to decompose. It is held that the results can only be interpreted if a mosaic structure is attributed to the crystals. M. H. H.

ALAREW (D.) & KARABASCHEW (N.). *Der disperse Bau der Realkristallsysteme und die Temperatur des Beginns der Grauglut.* Kolloid-Zeits., 1934, vol. 68, pp. 261–266, 6 figs.

From the variation of the temperature at which a grey glow first ppears on heating certain salts (with adsorbed impurities) it is con-luded that the salts must have a mosaic structure. M. H. H.

ALAREW (D.). *Die Dampfspannung in einem System mit zerriebenen Kristallen.* Zeits. Physikal. Chem., Abt. A, 1934, vol. 171, pp. 466–468.

The apparent equilibrium pressure of a crystal hydrate–water apour system is always higher than the thermodynamic equilibrium alue when the equilibrium is approached by the hydrate absorbing ater, and less when the hydrate loses water; the departures are duced when the material is finely powdered, but increase again on nding. M. H. H.

ERSMAN (A. E.)] Ферсман (А. Е.). Энергетическая характеристика геохимических процессов.—FERSMAN (A. E.). *Energy indices in geochemistry.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1935, vol. 2, pp. 263–266 (Russian), pp. 266–269 (English).

- Система эков.—*The EK system.* Ibid., 1935, vol. 2, pp. 559–563 (Russian), pp. 564–566 (English).

— *The periodic system of energy coefficients.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1935, n. ser., vol. 3 (8), pp. 173–176 (English).

he suggestion is made that energy coefficients (*EKs*) of the mical elements should be placed at the basis of the study of all chemical processes, such as the association of elements, sequence paragenesis of minerals, &c. The indices, termed *EKs*, correspond he amount of energy which is contributed to a heteropolar com-nd by each of the ions transported from infinity. The modified nula of A. F. Kapustinsky [M.A. **5**-456] for the energy of the stal lattice (U) reads as follows: $U = 256{\cdot}1\ (a.EK_{\text{cat.}} + b.EK_{\text{an.}})$, re a and b are the number of cations and anions respectively and $= Kw^2/2R$. In the last formula w represents valency and R c radius, and K an empirical coefficient which for anions is rly equal to unity. The value of *EKs* for different elements can calculated by means of the Kapustinsky formula, and the values ained are very near to those obtained by means of thermodynamic

equations. In this way the author obtains a complete set of energ coefficients for all the elements, and he proceeds to study these i their relation to the periodic system and to the chemical ar physical properties of the elements. S. I. T.

Fersman (A. E.). *The geochemical characteristics of protocristalliz tion.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1935, n. se vol. 3 (8), pp. 216–220 (English).

Examination of the minerals formed during the early phases crystallization of the basic and ultra-basic magmas shows that the hardness and the valence of their atoms is progressively decreasi with the advancing crystallization. The elements of even atom numbers predominate, and their energy coefficients (*EKs*) are ve high, while their atomic (ionic) volumes are low. This sugges that protocrystallization corresponds to minimum amount of store up energy in the minerals formed. S. I. T.

[Fersman (A. E.)] Ферсман (А. Е.). Геохимические параметры желе [*The geochemical parameters of iron.*] Успехи химии (Uspec Chimii), 1935, vol. 4, pp. 731–755 (Russian).

The geochemical functions of iron are outlined in relation to t fundamental chemico-physical parameters (atomic number, valen and ionic radius) and the derived parameters (co-ordination numb ionic polarization, and energy coefficient). The formation of differe compounds of iron is explained by means of parameters. S. I. T.

[Fersman (A. E.)] Ферсман (А. Е.). Применение эков для определен энергии решеток.—Fersman (A. E.). *The use of eks in det mining crystal energies.* Изв. Акад. Наук СССР, Отд. Мат. Е (Bull. Acad. Sci. URSS, Cl. Sci. Mat. Nat.), 1935, pp. 1425–14 (Russian with English summary.)

The law of additivity of *EKs* in the calculation of crystal latt energy of complex compounds is applicable to all cases where t ionic polarization is not strongly marked. S. I. T.

[Fersman (A. E.)] Ферсман (А. Е.). К геохимии щелочных ма *On the geochemistry of alcaline magmas.* Изв. Акад. Наук СС Отд. Мат. Ест. (Bull. Acad. Sci. URSS, Cl. Sci. Mat. Na 1935, pp. 1419–1424. (Russian with English summary.)

The study of the agpaitic order of crystallization, found not o among rocks of the nepheline-syenite group, but also among so rocks of the gabbro group, suggests that the late crystallization

he minerals rich in Fe and Ti is, to a great extent, determined by he ratios of strong anions to cations with the resulting formation of omplex anions with a low crystal lattice energy. S. I. T.

[Fersman (A. E.)] Ферсман (А. Е.). Применение вэков в геохимии.—Fersman (A. E.). *Applying of VEK's in geochemistry.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1936, vol. 2 (11), pp. 387–390 (Russian), pp. 393–396 (English).

VEK is *EK* divided by valency ($VEK = EK/W = W/2R$). The alculated *VEKs* for ions characterize the strength of chemical ffinity and vary with the *p*H. Certain geochemical conclusions re drawn. S. I. T.

ersman (A. E.). *Polar isomorphism.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1936, n. ser., vol. 1 (10), pp. 119–122 (English).

The suggestion is made that isomorphous substitution is deter-ined not only by atomic radii but also by the crystal energy. olar isomorphism occurs under conditions of unequal valencies, here ions of lower valency are usually replaced by ions of higher alency and higher energy. The same applies to endocrypty—perse elements enclosed by a crystalline lattice. S. I. T.

[Laemmlein (G. G.)] Леммлейн (Г. Г.). Порядок выделения силикатов и энергия их кристаллической структуры.—Laemmlein (G. G.). *Ausscheidungsfolge von Silicaten aus der magmatischen Schmelze und ihre Kristallgitterenergien.* Докл. Акад. Наук СССР (Compt. Rend. Acad. Sci. URSS), 1936, vol. 1 (10), pp. 29–31 (Russian), pp. 33–35 (German).

The order of crystallization of minerals out of magma roughly lows the decreasing order of the crystal-lattice energy (kcal/mol). S. I. T.

Miscellaneous.

[akar (V. A.), Knipovich (E. V.), & Shafranovsky (I. I.)] Вакар (В. А.), Книпович (Э. В.) и Шафрановский (И. И.). Людвигит из полярной Якутии.—Vakar (V. A.), Knipovich (E. V.), & Schaffanovsky [*sic*] (I. I.). *Ludwigite in polar Yakutia.* Зап. Всеросс. Мин. Общ. (Mém. Soc. Russe Min.), 1934, ser. 2, vol. 63, pp. 381–385. (Russian with English summary.)

Ludwigite, in the form of radial aggregates of black colour, is nd in hornblendite skarn between limestone and granite in the V. part of the Chersky range (NE. Siberia). Sp. gr. 4·29, H. 5,

soluble in acids. Analysis gave SiO_2 0·35, TiO_2 0·24, Al_2O_3 nil, Fe_2O_3 38·3, FeO 28·8, MnO 0·2, MgO 13·89, CaO 0·87, Na_2O 0·36, K_2O 0·0 B_2O_3 13·55, F 0·07, H_2O- 0·07, ign. loss 3·21 = '100·08'. This co responds to $R''_4B_2Fe_2O_{10}$, where $R''_4 = 2Mg + 2Fe$. S. I. T.

[Kazantzev (V. P.)] Казанцев (В. П.). О структуре и свойства вермикулита.—Kazanzew (V. P.). *On the structure and pr perties of vermiculite.* Зап. Всеросс. Мин. Общ. (Mém. So Russe Min.), 1934, ser. 2, vol. 63, pp. 464–480, 2 figs. (Russia with English summary.)

Chemical and X-ray study of vermiculite and biotite from Buldyr Urals, lead to the following conclusions. The unit cell of vermiculi is analogous to that of biotite but of slightly larger dimensions a with K partly replaced by H and Fe by Mg. Hydration is the ma factor of change from biotite to vermiculite. The swelling of verm culite on heating is explained by the presence of water between t atomic sheets and cleavage flakes. The soapiness and oiliness vermiculite are due to the presence of free alkalis on cleava surfaces. S. I. T.

[Godlevsky (M. N.) & Egorova (E. N.)] Годлевский (М. Н.) Егорова (Е. Н.). Ашарит из Индерского месторождения бор тов.—Godlevsky (M. N.) & Egorowa (E. N.). *Ascharit a der Inder-Boratlagerstätte.* Зап. Всеросс. Мин. Общ. (Mém. S Russe Min.), 1936, ser. 2, vol. 65, pp. 379–384, 1 pl. (Russi with German summary.)

Minute crystals of ascharite from the Inder borate deposit, Siber [M.A. **6**–336] gave B_2O_3 39·75, Al_2O_3 0·40, Fe_2O_3 0·11, MnO 0·0 MgO 47·11, CaO 0·52, $Na_2O + K_2O$ 0·05, Cl 0·09, CO_2 1·14, Si 0·74, H_2O+ 10·25, H_2O- 0·18 = 100·35; formula $2MgO.B_2O_3.H_2$ Water is expelled only at 800–900° together with B_2O_3. The opti data, α 1·575, β 1·642, γ 1·646, 2V small, negative, differ considerabl from those given for the original material from Ascherleben, Prussi L. J. S.

Kagaya (Bunjirô). *Crystal forms of alunite from Ukusu in the provi of Izu, Japan.* Journ. Jap. Assoc. Min. Petr. Econ. Geol., 19 vol. 16, pp. 276–286, 6 figs. (Japanese.)

Tabular crystals of about 1–2·5 mm. in diameter were measu and the following forms noted: c (0001), r ($10\bar{1}1$), ($10\bar{1}3$), ($10\bar{1}$ ($10\bar{1}5$), ($10\bar{1}6$), ($10\bar{1}7$), ($10\bar{1}8$), ($10\bar{1}9$), (1.0.$\bar{1}$.10), (1.0.$\bar{1}$.11), (1.0.$\bar{1}$.1 (1.0.$\bar{1}$.13), (1.0.$\bar{1}$.14), (1.0.$\bar{1}$.15), (1.0.$\bar{1}$.16), (1.0.$\bar{1}$.17), (1.0.$\bar{1}$.1

$(20\bar{2}5)$, $(20\bar{2}7)$, $(20\bar{2}9)$, $(3.0.\bar{3}.10)$, $(1.0.\bar{1}.58)$, and the negative rhombohedron $(01\bar{1}4)$. The axial ratio, calculated from $rr' = 89° 15'$, is $a : c = 1 : 1{\cdot}2043$. Sp. gr. 2·676 at 18° C. R. O.

Ôzu (S.), Takané (K.), & Kagaya (B.). *X-ray studies of alunite from Ukusu, province of Izu, Japan.* Journ. Jap. Assoc. Min. Petr. Econ. Geol., 1937, vol. 17, pp. 25–30, 1 fig. (Japanese.)

The mineral was studied by means of Laue, rotation, and Weissenberg photographs. The results are a 11·26, c 6·87 Å., and the mineral is assigned to the space-group D^2_{3d}. R. O.

Sawano (Y.). *Chemical composition of alunite from Ukusu, Izu, Japan.* Journ. Jap. Assoc. Min. Petr. Econ. Geol., 1937, vol. 17, pp. 31–37. (Japanese.)

The analyses show SO_3 39·67, Al_2O_3 37·54, Fe_2O_3 0·49, Na_2O 3·84, K_2O 4·32, H_2O+ 13·38, H_2O- 0·37, SiO_2 0·50 = 100·11, corresponding to $43[K_2Al_6(OH)_{12}(SO_4)_4] + 57[Na_2Al_6(OH)_{12}(SO_4)_4]$. R. O.

Wodzugutt (St. J.). *O pinicie boliwijskim z Chacaltaya.—Sur la pinite bolivienne de Chacaltaya.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1936, vol. 12, pp. 58–61 (Polish), pp. 62–63 (French résumé).

The green mineral, resembling chlorite, is associated with quartz, fluorite, chalybite, and tourmaline in a wolfram-tin vein in the Chocaltaya mine. Radiating needles form spheroidal encrustations; $2\frac{1}{2}$, sp. gr. 2·843. Analysis, SiO_2 46·25, Al_2O_3 31·89, Fe_2O_3 1·52, FeO 2·08, MnO 0·15, MgO 1·00, CaO 0·29, Na_2O 1·15, K_2O 10·18, H_2O+ 4·93, H_2O- 0·12, F 1·39 = 100·95, agrees with muscovite. The powdered mineral absorbs 8 % H_2O from the air, suggesting montmorillonite, but it differs from this in density and in not being attacked by HCl. It is probably an alteration product of biotite. L. J. S.

Wodzugutt (St. J.). *O rozpuszczalności barytu w wodzie przekroplonej.—Sur la solubilité de la barytine dans l'eau distillée.* Arch. Min. Tow. Nauk. Warszaw. (Arch. Min. Soc. Sci. Varsovie), 1936, vol. 12, pp. 75–79 (Polish), pp. 80–81 (French résumé).

— *O koloidalnym roztworze fluorytu.—Sur une solution colloïdale de la fluorine.* Ibid., pp. 187–190 (Polish), pp. 191–192 (French résumé).

Finely powdered baryte and fluorite heated in water in sealed tubes for 50 hours at 206° yielded solutions containing $BaSO_4$ 0·00126 and CaF_2 0·00296 g. per 100 c.c. respectively. L. J. S.

Fenoglio (Massimo). *Ricerche sull' artinite delle miniere di Cogne e val d'Aosta.* Periodico Min. Roma, 1936, vol. 7, pp. 47–5 1 pl. [Cf. M.A. **5**–287; **6**–143.]

Artinite forms thin crusts of white acicular crystals on serpe tine. Analysis, MgO 41·04, CO_2 22·21, H_2O 36·64 %, agrees wit $MgCO_3.Mg(OH)_2.3H_2O$. Sp. gr. 2·027, β 1·535, γ 1·556. The needl give straight extinction in the direction β; and in this direction X-ra give a spacing of 3·14 Å. L. J. S.

Fenoglio (Massimo). *Ricerche sull' idromagnesite.* Periodico Mi Roma, 1936, vol. 7, pp. 257–284, 2 pls.

Hydromagnesite from Texas, Lancaster Co., Pennsylvania (ar from Emaresa, val d'Aosta, Piedmont) gave: MgO 43·52 (43·16 CO_2 36·72 (37·10), H_2O 19·53 (19·65), sp. gr. 2·236 (—), β 1·5 (1·529), γ 1·544 (1·542). The crystals are orthorhombic bipyramid (not monoclinic [M.A. **2**–320]) as shown by the optical orientatio etch-figures, and X-ray patterns. Optic axial plane (001), $a \perp$ (10 with very large axial angle. Twins on (021) [Dana's axes]. The un cell a 9·32, b 8·98, c 8·42 Å. ($a : b : c$ = 1·0378 : 1 : 0·9376) would co tain 2·61 mols. of $4MgO.3CO_2.4H_2O$ or 2·04 mols. of $5MgO.4CO_2.5H_2$ the latter formula is therefore accepted. Space-group D_{2h}^1.

L. J. S.

Rondolino (Rinaldo). *Ricerche chimiche sulla gavite di val della Ga (gruppo di Voltri).* Periodico Min. Roma, 1936, vol. 7, pp. 20 210.

A new analysis of gavite, SiO_2 53·69, Al_2O_3 0·90, Fe_2O_3 2·21, Fe 1·80, NiO 1·89, MgO 27·01, CaO nil, $H_2O(+110°)$ 8·12, H_2O 3·94 = 99·56, gives a formula $5RO.6SiO_2.3H_2O$; sp. gr. 2·43 n 1·543, 1·591. [M.A. **1**–20; **2**–361.] L. J. S.

Cooke (H. C.). *The composition of asbestos and other fibres of Thetfo district, Quebec.* Trans. Roy. Soc. Canada, 1935, ser. 3, vol. 2 sect. 4, pp. 7–19.

Several analyses are given of carefully selected chrysotile different degrees of softness and harshness, and these are interpret as mixtures of serpentine ($H_4Mg_3Si_2O_9$), chlorite, talc, brucite, pe clase, &c. Harshness seems to be connected with excess of silica a the presence of more talc and periclase and less water. Analyses fibrous materials occurring on slickensided surfaces and in faults sho that these may range from serpentine to brucite. L. J. S.

ANERO (Edoardo). *Ricerche chimiche sulla tinzenite e parsettensite della miniera di Cassagna (Liguria).* Periodico Min. Roma, 1936, vol. 7, pp. 123–132.

Analyses are given of the minerals previously recorded from this cality [M.A. **6**–96]. Tinzenite, as veinlets in manganese oxides raunite and pyrolusite), gave I for the salmon-pink variety and II r the orange-yellow; $2CaO.Mn_2O_3.Al_2O_3.4SiO_2$. Parsettensite, as a in yellow-brown coating, gave III; $3MnO.4SiO_2.3H_2O.H_2O$.

	SiO_2.	Al_2O_3.	Fe_2O_3.	Mn_2O_3.	MnO.	MgO.
I. ...	42·10	18·05	0·27	23·70	—	0·58
II. ...	41·77	19·04	0·94	22·95	—	0·66
III. ...	42·79	3·96	0·45	—	35·76	1·62

	CaO.	Na_2O.	K_2O.	H_2O+.	Total.	Sp. gr.
I. ...	13·71	0·33	0·10	1·22	100·06	3·264
II. ...	12·97	0·53	0·18	1·28	100·32	3·301
III. ...	1·24	0·21	0·61	9·02	99·33	2·607

I and II, also TiO_2 trace, H_2O- nil. III, also TiO_2, NiO, P_2O_5 traces, H_2O- 3·67.

L. J. S.

LLÈRE (*Mlle* S.). *Contribution à l'étude des minéraux des serpentines.* Bull. Soc. Franç. Min., 1936, vol. 59, pp. 163–326, 2 pls., 7 text-figs.; reprints as Thèse, Univ. Paris, 1936, 173 pp., 2 pls., 7 text-figs.

This contribution includes thirty-two new chemical analyses of pentine minerals and ten analyses of minerals formerly classed th them but now shown to be distinct. Optical, specific gravity, d thermal data accompany most of the chemical work, and X-ray wder photographs have been utilized to differentiate the various nerals and also to study the products formed on calcination at own temperatures. A detailed study of a large number of speci-ens from various localities led to the following classification. Ser-ntine minerals include antigorite, metaxite, picrolite, baltimorite, lliamsite, deweylite, cerolite, picrosmine, garnierite, noumeite, pouite, pimelite, and chrysotile. X-ray photographs of all these nerals are identical and they have essentially the same composi-n $H_4Mg_3Si_2O_9$, but thermal studies reveal two main types, anti-rite α and antigorite β, the latter predominant. Antigorite α loses water content at 650° C. and passes into an amorphous mixture ich crystallizes at 750° C. with marked evolution of heat to a xture of enstatite and olivine. Antigorite β passes on dehydration

at 650° C. into the same crystalline mixture without the amorphou transition and gives no incandescence phenomena at 750° C. Mos chrysotile ranks as antigorite β. Lamellae of typical antigorite ar found to consist of a rectangular network or felt of minute fibres an to this structure is attributed the variation in optical sign and opt axial angle. Garnierite consists essentially of antigorite impregnate with nickel oxide, but several so-called noumeites have been show to consist of sepiolite, talc, or mixtures of these minerals with nickel ferous antigorite. The existence of ferriferous antigorite has not bee established, bowlingite being a variety of saponite, whilst xyloti should be classed as a distinct species. [M.A. **5**–427, 522; **6**–6 141.] F. A. B.

Selfridge (George C. *Jr.*). *An X-ray and optical investigation of t serpentine minerals.* Amer. Min., 1936, vol. 21, pp. 463–50 18 figs.

The large number of serpentine varieties, with massive, lamella and fibrous structures, were found from their X-ray patterns to fa into two groups: serpentine (including chrysotile, schweizerit metaxite, pyroidesine, marmolite, retinalite, thermophyllite, bastit and vorhauserite) and antigorite (including picrolite, picrosmin williamsite, bowenite, porcellophite, and baltimorite). Serpenti has n 1·538–1·570, $\gamma - \alpha$ 0·007–0·008, 2V small, negative (rare positive). Antigorite has n 1·555–1·580, $\gamma - \alpha$ 0·005–0·007, 2V sma negative. The complex micro-structures of the several varieties a described in detail: all of them are ultimately fibrous. In serpenti the fibres are either negative (α-serpentine) or positive (γ-serpentin in elongation. A tabulation of chemical analyses shows no essenti variation from the formula $H_4Mg_3Si_2O_9$, and serpentine and an gorite thus appear to be dimorphous. The rock serpentinite m consist of serpentine or antigorite, or both. The matrix of chrysot veins appears to be always serpentine, chrysotile being more distinct crystallized serpentine. Deweylite and some other related miner are also described. L. J. S.

Longchambon (Henri) & Migeon (Georges). *Sur les sépiolites.* Comp Rend. Acad. Sci. Paris, 1936, vol. 203, pp. 431–433. [Cf. M. **6**–63, 142.]

Three new samples of sepiolite have been examined. All cons of interlaced fibres, one ('mountain-leather') of unknown locality tough and supple, the others ('mountain-pasteboard'), from Piedmo

nd Strážek, Moravia, less supple to brittle. Their analyses correspond ith the formula $Si_4O_{11}Mg_{2\cdot7-2\cdot8}H_{0\cdot4-0\cdot6}.H_2O.(H_2O)_z$, where z denotes olitic water and = 3·4–3·9. In this formula the small amounts Al_2O_3, CaO, K_2O, and Na_2O have been included with the MgO. ll tests agree with those of the sepiolites previously examined, but o not support de Lapparent's views. C. A. S.

IGEON (Georges). *Contribution à l'étude de la définition des sépiolites.* Bull. Soc. Franç. Min., 1936, vol. 59, pp. 6–134, 3 pls., 6 text-figs.

This thesis collects and amplifies the results previously published [M.A. **5**–334, 521; **6**–62, 63, 142, 236]. Earlier analyses of sepiolite (meerschaum) show ratios $SiO_2/MgO(+FeO,CaO)$ ranging from 1·19 1·80, with 2–4H_2O. Eight new analyses on purer material show a nge 1·30–1·70. The dehydration, changes in volume on heating, olitic behaviour, and X-ray patterns at different stages are studied detail. The general formula is deduced as

$$(Mg,H_2)_3Si_4O_{11}.1H_2O.nH_2O.$$

L. J. S.

NGCHAMBON (Henri). *Les courbes de déshydratation des minéraux.* Bull. Soc. Franç. Min., 1936, vol. 59, pp. 145–161, 1 pl., 9 text-figs.

An apparatus is described for recording on photographic paper the nge of weight of a mineral specimen with rise in temperature. hydration curves for palygorskite, kaolinite, and steatite are produced. The form of curve obtained depends not only on the neral but on the time allowed for dehydration and on crystal size. avage flakes of muscovite yield a curve indicating a well-defined drate which begins to decompose at 800° C. The same specimen nen powdered yields a curve with scarcely any flexure, whilst the rve for sericite shows a continuous evolution of water with rise in mperature. [M.A. **6**–63, 142, 236.] F. A. B.

URAVSKY (Georges). *Sur la composition chimique des titanomagnétites.* Compt. Rend. Acad. Sci. Paris, 1936, vol. 202, pp. 1689–1691.

From a consideration of previous results (e.g. of Ramdohr, 1925) d comparison of the reflecting and magnetic powers of several anomagnetites, and in particular of some very homogeneous grains m Madagascar containing considerable amounts of Al_2O_3 (6·08 to

13·21 %) and MgO (4·75 to 7·07 %), it is suggested that the presenc of these oxides favours homogeneity, if indeed it is not essenti therefor. C. A. S.

Cayeux (Lucien). *Structure réticulée de la silice, observée dans d phtanites précambriens et des phosphates suessoniens.* Comp Rend. Acad. Sci. Paris, 1936, vol. 203, pp. 6–8.

In some pre-Cambrian phthanites from Bréhec (Finistère) a retic lated structure extends throughout the whole mass. The meshes a 0·01–0·03 mm. across. The material of the network is cryptocrysta line, lying between quartz and chalcedonite, while the interstices a filled in with isotropic opal. A similar structure, also of SiO_2, b with smaller meshes (5–6 μ) occurs in a bed of Lower Eocene phospha at Metlaoui. An algal origin is suggested. C. A. S.

Kivinen (Erkki). *Ein Doppleritfund aus Keuru in Mittelfinnlan* Bull. Comm. Géol. Finlande, 1936, no. 115 (= Compt. Ren Soc. Géol. Finlande, no. 9), pp. 69–73, 1 fig.

Crevices and nests in clay beneath peat are filled with soft pitc black dopplerite When dried it breaks up into small lustrous fra ments. At 105° C. the loss is 86·16 %. The dry material contai 12·79 % ash (clay). The organic substance gave C 45·56, H 6·1 N 1·78, O 46·47 %. L. J. S.

Ant-Wuorinen (Jalo). *Der Wiikit und seine chemische Zusamme setzung.* Bull. Comm. Géol. Finlande, 1936, no. 115 (= Comp Rend. Soc. Géol. Finlande, no. 9), pp. 213–229, 4 figs.

Six new analyses are given of wiikite (sp. gr. 3·750–4·997) fro Nuolainniemi and Lokansaari, Finland. Micro-sections show th the material is not homogeneous, and other analyses are given separated fractions. The mineral is regarded to be an isomorpho mixture of α-wiikite $Ca_3U(HNbO_5)_3$ and β-wiikite $Y_4(HNbO_5)_3$. [M.A. **4**–249.] L. J. S.

Hietanen (Anna). *Über den Rhodonit und andere Manganminer von Simsiö, Pohjanmaa.* Bull. Comm. Géol. Finlande, 19 no. 115 (= Compt. Rend. Soc. Géol. Finlande, no. 9), pp. 38 400, 7 figs.

Lenticles of diopside and of rhodonite occur in quartzite. T massive red to brown rhodonite is fine- to coarse-grained; anal. IV. The refractive indices increase with the amount of iron a

ecrease with increase of Mg and Ca. Brown-red crystals of spessar-
me gave V. Pale red manganocalcite has ω 1·6664, ϵ 1·4959.

	SiO_2.	FeO.	MnO.	MgO.	CaO.	H_2O.	Total.	α.	β.	γ.
II.	46·51	19·12	29·34	1·96	2·94	0·25	100·12	1·739	1·748	1·760
II.	46·84	7·33	38·92	2·83	3·44	0·26	99·62	1·730	1·736	1·746
II.	47·01	3·70	45·04	1·72	2·43	0·15	100·05	1·728	1·734	1·742
V.	46·78	1·64	46·37	1·43	3·70	0·12	100·04	1·722	1·729	1·738

	SiO_2.	TiO_2.	Al_2O_3.	FeO.	MnO.	CaO.	MgO.	H_2O+.	Total.
V.	46·57	nil	0·73	3·70	46·28	1·60	0·12	0·72	99·72

L. J. S.

HIBATA (Hidekata). *Graphic intergrowth of cordierite and quartz from Sasago and Dôsi, province of Kai, Japan.* Japanese Journ. Geol. Geogr., 1936, vol. 13, pp. 205–227, 1 pl., 19 text-figs.

Pegmatites intrusive into sandstone (at Sasago) and amphibolite Dôsi), and contaminated with these rocks, contain an intimate ergrowth of cordierite and quartz on a small scale, with a regular ystallographic orientation between the two minerals. Deducting -4 % and 56·7 % quartz (determined micrometrically), the com-ition of the iron-rich cordierite is I from Sasago and II from si; formula, $H_2O.2(R_2O,RO).2R_2O_3.5SiO_2$. These results are ulated and plotted with previous analyses. The sp. gr. and refr. ices increase with the amount of iron; $2V_\alpha$ ranges from 0° in iron-magnesia-cordierite to over 90° with about 15 % of the iron-dierite molecule, decreasing to about 43° with about 40 %, and h still more iron again increasing, but still remaining optically gative.

	SiO_2.	Al_2O_3.	Fe_2O_3.	FeO.	MnO.	MgO.	CaO.	Na_2O.	K_2O.
I	43·27	30·25	1·09	15·31	1·20	1·48	0·10	3·53	0·90
I	43·55	30·68	1·50	13·17	2·88	2·70	0·16	1·32	0.32

	H_2O+.	Total.	Sp. gr.	α.	β.	γ.	$2V_\alpha$
	2·89	100·00	2·75	1·558	1·568	1·573	68½°
	3·72	100·00	2·72	1·555	1·566	1·571	66°

L. J. S.

RTY (Julian J.). *The origin and occurrence of fulgurites in the Atlantic coastal plain.* Amer. Journ. Sci., 1936, ser. 5, vol. 31, pp. 188–201, 6 figs.

More than a hundred fulgurites were collected in sand pits in taceous sands in North and South Carolina. They vary from

$\frac{1}{8}$ to 1 (average $\frac{3}{8}$) inch in diameter, and have been traced downward to a depth of sixty feet. There is no marked tapering of the tube downwards. The thickness of the walls varies from several millimetres to paper thinness; and sometimes they are discontinuous and lace-like. Many branch and rebranch, and the direction may abruptly change along the bedding planes of the sand. A zone of reddish sand usually less than $\frac{1}{4}$ inch thick, commonly surrounds the tubes. The glass is colourless, greyish, or black, usually with a uniform tint, but sometimes mottled. The tubes are circular (very rarely oval) in cross-section; but sometimes flattened, evidently due to collapse while the material was still plastic. A striking picture is given of an artificial fulgurite (14 cm. long, 1·5 cm. diam.) made by the General Electric Company by passing high voltage discharges into a pail of sand. Artificial fulgurites have sometimes been formed when a high tension wire came in contact with the ground. A bibliography of 86 items is given [but several references in this Magazine and Abstracts have been missed]. L. J. S.

Gruner (John W.). *The structure of greenalite.* Amer. Min., 1936, vol. 21, pp. 449–455.

Greenalite granules isolated from the greenalite-rock of the Mesabi Range, Minnesota, give an X-ray pattern very similar to that of serpentine. They are not optically isotropic, and the supposed metagreenalite [M.A. **6**–152] is the same material of coarser grain. The material is intimately intermixed with quartz, and a recalculation of the analyses gives the formula $9FeO.Fe_2O_3.8SiO_2.8H_2O$, corresponding to an iron-serpentine. L. J. S.

Gunning (H. C.). *Knebelite from Bluebell mine, Kootenay Lake, B.C.* Trans. Roy. Soc. Canada, 1936, ser. 3, vol. 30, sect. 4, pp. 19–22, 1 pl.

Dark green to black patches of knebelite occur in Fe–Mn carbonate associated with pyrrhotine, galena, &c., in limestone intruded by granite. It has 2V 60°±, β 1·81; analysis by R. J. C. Fabry gives SiO_2 28·93, Al_2O_3 nil, Fe_2O_3 4·06, FeO 39·15, MnO 24·82, MgO 0·30, CaO 0·68, H_2O+ 2·01, H_2O- 0·10 = 99·80. L. J. S.

Yuster (S. T.). *A theoretical consideration of ideal liquid inclusions.* Amer. Journ. Sci., 1936, ser. 5, vol. 31, pp. 363–372.

Calculations are made of the temperatures and pressures that existed at the time when liquids or gases were enclosed in crystals. L. J. S.

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